HOUSEHOLD CHEMISTRY

A LABORATORY GUIDE

J. MAUD BLANCHARD

ALLYN AND BACON

HOUSEHOLD CHEMISTRY FOR GIRLS

A LABORATORY GUIDE

BY

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PREFACE.

To outline a strong course in chemistry, especially suited to girls of high school age, is the purpose of this book. Several years' experience in developing this course has strengthened the author's conviction that it is better in every way to give girls special work in chemistry rather than to make their study identical with that for boys. In the Los Angeles High School, where this plan has been followed for some time, it has brought about a gratifying increase in the number of girls studying chemistry.

But it was with no intention of weakening the course or of presenting to girls merely the "pyrotechnics" of chemistry that the differentiation has been made. On the contrary, the same standard of thoroughness has been maintained for both boys and girls, with the result that full credit has been granted by the authorities of the University of California for the year's work in household chemistry.

Though our ultimate aim is the training of intelligent homemakers, this is a manual of chemistry, *not* of domestic science. It is therefore suitable for a purely academic high school, no less than for a polytechnic high school, where a rigorous course in household chemistry forms a necessary foundation for the work in domestic science. The choice of subjects is based in a general way on the following scheme:

What we breathe.

What we drink and use for cleansing.

What we use for fuels and illuminants.

Chemical nature of common substances.

Foods and food values.

Adulterants and simple methods for their detection.

Textiles — care of textiles, removal of stains, etc.

The principles of inorganic chemistry — to which the first half of the book is devoted — are developed from a study of common substances, with special reference to their life interest and practical applications. This offers a scientific treatment of the subject, while making it more useful and attractive to the student.

The second half of the book, beginning with Experiment 28, is devoted to qualitative experiments in organic chemistry, as delicate quantitative experimentation is beyond the ability of high school pupils. Supplementary reading is of course advisable in this connection; with this in view, a full list of library text-books is given, and definite references to these accompany the experiments.

For the convenience of teachers, an alphabetical list of the necessary apparatus and chemicals is included, though the laboratory equipment differs but slightly from that of the regular course for boys. Other features, such as a list of exhibits and charts, suggestions for work at home, references for further reading along lines that are not so essential, but are of allied interest, have also been added.

Los Angeles, January, 1912.

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Part II. Simple Organic Chemistry.

HOUSEHOLD CHEMISTRY FOR GIRLS.

DIRECTIONS FOR LABORATORY WORK.

The Table. — When the work is completed, all apparatus should be removed from the table and the top carefully cleaned. The drawer should be lined with clean paper. Apparatus easily broken, as test-tubes and beaker, should be kept in boxes.

The Burner. — To light the Bunsen burner, turn the gas on full, and apply a lighted match about four inches above the burner; then lower the gas to the desired height. If the match is held close to the burner, the flame is liable to "strike back," that is, to burn at the base. In such a case, turn off the gas, let the burner cool, and then relight it. It is dangerous to let the base of the burner become heated, as the connecting rubber tubing melts and allows a large stream of gas to burn. The flame should be a clear blue and deposit no soot.

The Apparatus. — (*a*) The names of the pieces of apparatus should be learned at the outset.

(*b*) All apparatus should be clean before work is begun. Clogged connecting-tubes will cause an explosion.

(*c*) In using a ring-stand, place it at your right hand and extend the apparatus to the left.

(*d*) The lower end of a thistle-tube should extend below the surface of the liquid in the bottle or flask. The safety-tube has a bulb, hence its lower end does not need to dip into the liquid. Be sure that some of the liquid, when poured into the funnel top, remains in the bulb.

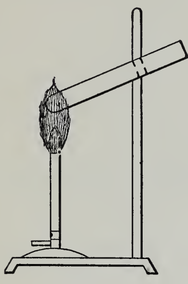


Fig. 1.

(*e*) In using a clamp with a test-tube or flask, press gently but firmly.

(*f*) Rubber tubing and rubber stoppers should be soft and pliable. The safety-tube and glass tubing, used as delivery tubes and connections, should fit the holes of the rubber stopper very snugly. Stoppers that fit closely may be removed by constant turning instead of pulling. Glass tubing should fit rubber tubing.

(*g*) Heat glass or porcelain gently, at first; increase the heat gradually.

In heating a test-tube, turn the mouth of the tube so that it does not point towards you or your neighbor. Constantly move the tube. Hold it in the upper part of the flame (Fig. 1).

In heating a flask, beaker, or evaporating dish, place a wire screen or asbestos mat over the iron support (Fig. 2).

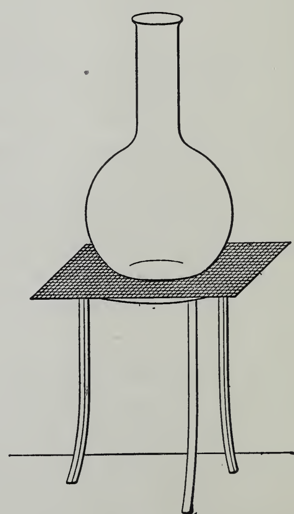


Fig. 2.

To cut Glass Tubing. — At the point to be cut, make a deep scratch with a triangular file. Do not move the file back and forth. Place the thumbs opposite the scratch and bend the

two ends towards you; at the same time, pull the pieces apart.

To bend Glass Tubing. — Place a "wing burner" on the top of a Bunsen burner. Hold the tubing lengthwise in the broad flame. Rotate while heating until the tube is soft. Remove it from the flame and bend it. Make a curved bend: an angular bend is easily broken. The ends of the tubing should be made smooth by holding them in the flame until they become red and soften slightly.

The Chemicals. — Concentrated acids should seldom be used by the student, and great care should be taken in handling them. In diluting concentrated sulphuric acid, water should be put into an empty bottle and then the acid added, a little at a time. The mixture must be kept very cool during the process. *Water* must *never* be poured into concentrated sulphuric acid. For the sake of good results as well as for economy, reagents and solid chemicals should be used in small quantities. After using a reagent bottle, replace the stopper *at once.* If more of the reagent has been withdrawn than needed, throw it away. *Never* pour any unused reagent back into the bottle.

Waste Matter. — Only liquids should be thrown into the sink. All solid waste matter should be placed in stone jars or boxes.

Caution! Keep gas and water turned off when they are not in use.

PART I.

INORGANIC CHEMISTRY.

1. INTRODUCTION.

THE main purpose of this course is to present the principles of chemistry that will be especially useful to a young woman. The topics chosen for study, then, will necessarily differ from those of the ordinary text-book in chemistry, though the matter to be studied in connection with the experiments in Part I may be found in any standard elementary chemistry. The First Principles of Chemistry, by Brownlee and Others, is particularly well adapted for this purpose. For the convenience of the student, specific references to this text-book are given with each experiment.

In addition to the topics indicated by the references, the chemical laws and theories that are needed to give a broader meaning to the experiments should be discussed by the class.

Six forty-five minute periods a week are required for the laboratory exercises and recitations in household chemistry.

The note-book should contain a complete record of the work performed by the student, including the observations, explanation of results, and general conclusions. The drawings should be simple outlines, made for use and not for ornament.

EXPERIMENT 1.

Physical Change.

First Principles of Chemistry, Brownlee and Others, Chapter I.

MATERIALS. Salt, glass rod, iodine, fountain penholder, rubber comb.

1. Dissolve a little salt in a test-tube one-fourth full of water. Dip a clean glass rod into the liquid and taste it. Dip the rod into the liquid again and hold it *over*, not *in*, the flame of the Bunsen burner. Taste the solid that appears. What is it? What kind of change did the salt undergo? What caused the change?

2. Drop a small crystal of iodine into a *dry* test-tube and gently heat the bottom. Remove the tube from the flame and let it cool. How has the iodine been changed? What caused the change? Pour a little alcohol into the test-tube and shake until all of the iodine has dissolved. What kind of change has the iodine undergone? Give the iodine solution to the instructor.

3. Rub a fountain penholder or a rubber comb briskly on a piece of cloth and hold it near small bits of dry paper. After a moment touch the paper again. Is the result the same? Try again. What kind of change did the substances undergo?

EXPERIMENT 2.

Chemical Change.

First Principles of Chemistry, Chapter I.

MATERIALS. Magnesium ribbon, copper wire, dilute nitric acid, pincers.

1. Hold a small piece of magnesium ribbon in the Bunsen flame by means of pincers. Note the change that takes place. Hold some of the solid produced in the flame. Does it burn? What kind of change has the magnesium ribbon undergone?

2. Examine a piece of copper wire and notice especially its color. Grasp one end of the wire with the pincers and hold the other end in the flame until a definite change occurs. Remove it and examine. Do the original properties of the copper reappear when the heated wire is cool? Has the change produced another substance?

3. Slip another piece of copper wire into a test-tube containing a little dilute nitric acid. Notice any change. Warm gently. What are the evidences of chemical change? What caused the change? What hastened it? How has the copper been changed? Boil the solution to dryness in a hood. What is the solid left?

EXPERIMENT 3.

Study of a Match.

First Principles of Chemistry, pages 202, 203.

MATERIALS. Sulphur matches, phosphorus matches, phosphorus, sulphur, lime-water, bottle and stopper, beaker, pieces of board.

(A) Phosphorus.

1. Rub the end of a phosphorus match on your finger in the dark. What is the appearance of the streak?

2. Light a match by rubbing the tip on a rough surface. What is the color of the flame at first? Describe the color and smell of the fumes that first go off into the air.

3. Observe the instructor while he cuts off a piece of phosphorus. What are some of the physical properties of phosphorus? Compare the smell of the phosphorus with the smell of the match tip in 1 above. What, therefore, is one of the substances found in the head of a match?

Caution! Phosphorus must never be handled with the fingers and should always be cut under water.

4. After the water has been removed from the phosphorus by means of blotting paper, what do you observe? In what other part of this experiment have you observed a similar substance? Why is phosphorus kept under water? Why should phosphorus-tipped matches be kept in glass or metal boxes?

(B) Sulphur.

1. Examine some common sulphur. What are its physical properties? What evidence of sulphur can you see near the match tip.

2. Light a sulphur match, and after the white fumes have disappeared, smell cautiously of the burning match head. What kind of odor has it? What is the color of the flame?

3. Light some sulphur with a heated wire. What is the color of the flame? Notice the smell of the burning sulphur. In what other part of the experiment have you noticed a similar odor and flame?

(C) **Water.**

1. After the wood of a match is burning well, hold it a little distance beneath the mouth of an inverted dry beaker. What do you see on the sides of the glass?

2. What is one of the substances, therefore, that is formed?

(D) **Carbon.**

1. When the wood of the match has been charred, extinguish the flame. (The substance left is called charcoal, or carbon.) What are some of the physical properties of carbon?

2. Heat the carbon red hot. Does it burn? How do you know? Why does it not make a flame?

3. Thrust a piece of wood through a hole in the stopper that fits tightly in the mouth of a bottle. Light the wood and insert the burning piece of wood into the bottle, closing the mouth with the stopper. What do you observe? Suggest an explanation of this fact.

4. Remove the stick, pour into the bottle a little clear lime-water and shake. What change do you observe in the lime-water? (When carbon burns it combines with the oxygen gas of the air, forming carbon dioxide.) How, then, can the presence of carbon in wood be demonstrated?

(E) Mineral Compounds.

1. Burn a match as long as you can. What are some of the physical properties of the ashes? (The ashes represent the mineral compounds of wood, carried up from the earth into the sap. When the water of the sap evaporated, the solid substances were left behind as a part of the wood.)

2. Heat these mineral compounds as hot as you can. Will they burn?

3. How could you determine, therefore, whether or not a substance contained mineral matter?

(F) Summary.

1. Name in order the parts of a match that will burn, beginning with the most inflammable.

2. Name the substances produced by the burning of each of the above ingredients, and state how each can be recognized.

3. What are the ingredients of a match that will not burn?

4. How are the materials in the head of the match made to adhere to the wood?

5. What substances are used in the mixture on the head of a "parlor match"? What is the use of each?

6. Describe the safety match. Why is it safe?

2. THE ATMOSPHERE.

EXPERIMENT 4.

Study of Oxygen.

First Principles of Chemistry, Chapter III.

MATERIALS. Apparatus stand, large test-tube, perforated stoppers, side-neck test-tube, delivery tube, pneumatic trough, one vaseline bottle, four large gas receivers, a piece of glass to cover each bottle, potassium chlorate, black oxide of manganese, splinters of wood, sulphur, bits of charcoal, picture wire, phosphorus, combustion cup.

1. Mix a spoonful of *pulverized* potassium chlorate with one-fourth this amount of black oxide of manganese. Put the mixture into the large test-tube and attach it to an apparatus stand in a slanting position. Connect the large test-tube with the side-neck test-tube. This tube must be empty. Why? Attach a delivery-tube to the

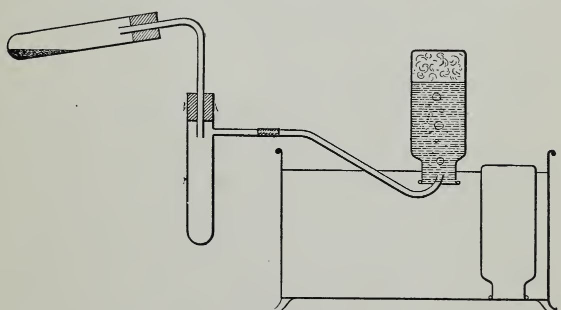


Fig. 3.

arm of the side-neck tube and let the other end of the delivery tube extend beneath the surface of the water in

the trough, as in Fig. 3. Heat the test-tube gently. What do you observe?

2. Fill the five bottles with water and cover each with a piece of glass. Insert one in the trough of water over the end of the delivery tube and remove the glass cover.

(*a*) Why does the bottle remain filled with water?

(*b*) Continue to heat slowly the mixture in the test-tube. What do you observe?

3. When the escaping oxygen has filled the bottle, cover it with a glass plate, remove it from the tray, and turn it right side up. Fill the other bottles in the same way. Why is the glass cover placed over each bottle?

Caution! Remove the delivery tube from the water, while the test-tube is still being heated.

4. What is the color of the oxygen obtained? Remove the glass from the bottle and smell of it. What do you find? Inhale some of the gas through the mouth. Has it any taste? What are the physical properties of the oxygen in the air? Of pure oxygen?

5. Introduce a burning stick into the vaseline bottle filled with oxygen.

(*a*) What do you observe?

(*b*) Remove the stick quickly and blow out the flame, leaving a glowing end. Again thrust the stick into the bottle of oxygen. What is the result?

(*c*) Repeat the preceding experiment several times. What do you finally observe? Explain this fact.

(*d*) Into the bottle put some clear lime-water, and shake. What is the result, and what do you infer?

6. Into another bottle of oxygen lower some burning sulphur. Place a cardboard square over the handle of the combustion cup so that it will cover the mouth of the

bottle when the glass square is removed before heating the sulphur.

(*a*) What do you observe? Does sulphur burn better in air or in oxygen?

(*b*) When the flame is extinguished, cover the bottle again with the glass. Cautiously smell of it. What is the gas? What are the physical properties of this gas?

7. Heat the end of a picture wire fastened to the handle of a combustion cup, and dip it into sulphur. As in 6, place a cardboard cover over the other end of the handle. When the little ball of sulphur is burning well, lower the heated picture wire into a bottle of oxygen. Describe the result? Will iron burn in the air? Why does it not make a flame?

8. Observe the instructor while he introduces a small piece of burning phosphorus into a bottle of oxygen.

(*a*) What do you observe? Does phosphorus burn better in air or in oxygen? What is the color of the flame?

(*b*) What do you see in the jar in which the phosphorus has been burning? Name this compound.

9. Introduce glowing charcoal into a jar of oxygen.

Did the oxygen burn in any of the preceding experiments? Does the oxygen of the air ever catch fire? How do you know?

What, then, does the oxygen do in each experiment?

(By burning, or oxidation, is meant the chemical union between oxygen and some other substance.)

How can you tell when oxidation is going on? Name the compounds that have been formed by oxidation in the preceding experiments. What change do you notice? Why does it not produce a flame? What compound is formed?

EXPERIMENT 5.

Study of Nitrogen.

First Principles of Chemistry, Chapter XIX.

MATERIALS. Flask, safety-tube, delivery tube, rubber stopper, pneumatic trough, vaseline bottles, glass covers, splints, potassium or sodium nitrite, ammonium chloride.

1. Mix small quantities of potassium nitrite and ammonium chloride, put the mixture into the flask, and pour a little water upon it through a safety-tube.

2. Heat very gently, and collect in the vaseline bottles, the gas evolved, after allowing time for the air to be expelled from the flask. The ammonium chloride and potassium nitrite unite to form ammonium nitrite and potassium chloride. The ammonium nitrite is then decomposed by the gentle heat, yielding nitrogen gas and water. The potassium chloride remains in the flask, dissolved in the water.

Why should the mixture be heated so gently?

3. What physical properties of nitrogen does the experiment teach?

4. Will the gas burn? Will it support combustion? What is its most important chemical property?

5. Collect a large bottle half full of nitrogen. Mark the height of the water left in the bottle with a rubber band. Allow it to remain inverted over the trough of water for several days. Does the water rise in the bottle? What would you judge about the solubility of nitrogen?

6. In like manner invert over water a bottle half full of oxygen and allow it to stand. Compare the solubility of these gases. Is the solution physical or chemical?

EXPERIMENT 6.

Study of Carbon Dioxide.

First Principles of Chemistry, pages 244-249.

MATERIALS. Lumps of marble, sand, dilute hydrochloric acid, side-neck test-tube, one-holed rubber stopper, corks, safety-tube, vaseline bottle, larger bottle, two small test-tubes, candle, lime-water, splint, elbow, glass covers.

1. Put some sand into a side-neck test-tube, add some powdered marble mixed with lumps. Pour hydrochloric acid upon the marble through the safety tube. Collect the gas that forms by displacement of water, as in the preparation of oxygen. Be sure that a bottle of water is inverted over the trough before the acid is added. Heat gently when the action stops. More acid may be added from time to time.

2. Plunge a burning splint into the vaseline bottle filled with carbon dioxide gas. Result? What chemical property does this show?

3. Lower a lighted candle into a bottle of air and invert the large bottle of carbon dioxide over it, holding the bottles mouth to mouth. What does the result show about the density of carbon dioxide?

4. Pour a little lime-water into a test-tube of the gas, cork and shake. What chemical change takes place?

5. Fill a beaker three-fourths full of water. Invert a test-tube of carbon dioxide over the water and let it remain over night. Does the gas dissolve? What substance is produced? State the physical and chemical properties of carbon dioxide.

EXPERIMENT 7.

Separation of the Nitrogen and Oxygen of the Air.

First Principles of Chemistry, Chapter XIX, page 170.

MATERIALS. Jar of water, flat piece of cork or piece of charcoal, wide-mouthed bottle, phosphorus, glass square, splint, cylindrical graduate, wire.

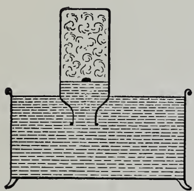


Fig. 4.

(A) 1. Pin a small piece of phosphorus to the piece of charcoal and float this on the water in the large jar (Fig. 4). Light the phosphorus with a hot glass rod and then quickly cover it with the inverted wide-mouthed bottle, keeping the rim of the latter about an inch below the surface of the water.

(*a*) With what was the bottle filled when it was placed over the burning phosphorus?

(*b*) As the phosphorus burns, what do you see within the jar? What is the composition of this substance? How was it formed?

(*c*) What ingredient, therefore, of the air is being removed? Why does the phosphorus, after a time, cease to burn?

(*d*) What change do you see in the level of the water within the bottle? How do you explain this?

(*e*) What change do you see in the compound that was formed within the bottle? Explain.

2. Slide a glass cover beneath the mouth of the bottle, invert, taking care not to lose any of the water that has risen in the jar. The largest part of the air left in the bottle is nitrogen. What are the lesser parts? Keep

the bottle covered, and shake the water about to wash the nitrogen as much as possible. Drop a piece of blue litmus paper into the water. What change do you see? What has been produced?

3. What are the physical properties of the nitrogen in the bottle? What are the physical properties of nitrogen in the air? Is the nitrogen in the bottle pure?

4. Observe the instructor while he places a small piece of phosphorus in a combustion cup and lights it, then carefully removes the glass cover and lowers the burning phosphorus into a jar of nitrogen.

(*a*) What do you observe?

(*b*) What, then, is the most striking difference between the effect of oxygen and nitrogen on heated phosphorus?

(*c*) Did the nitrogen itself burn?

(*d*) Does nitrogen make things burn?

(*e*) What is the advantage of having air composed chiefly of both oxygen and nitrogen?

(B) 1. Place a graduated tube mouth downward in a dish of water, adjusting it so that the water within and without the tube stands at the same level. (See Fig. 5 *a*.)

2. Note the volume of air enclosed.

3. Place a piece of phosphorus on the end of a wire. Carefully insert it in the graduate so that the phosphorus stands several inches above the level of the water.

4. Allow the apparatus to stand until the water ceases to rise (Fig. 5 *b*), then lower the graduate until the water within and without again stands at the same level.

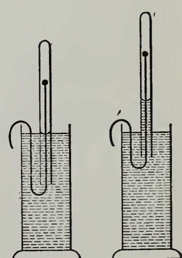


Fig. 5.

5. Note the volume of gas left in the tube.

6. Carefully remove the graduate as in the preceding experiment and test the liquid with blue litmus paper.

7. Introduce a blazing splint into the gas.

(*a*) What appeared in the graduate soon after the phosphorus was introduced?

(*b*) What became of this substance?

(*c*) What was the gas left in the graduate?

(*d*) What per cent of the air disappeared?

(*e*) What could you conclude the average per cent of oxygen and nitrogen of the air to be?

(*f*) Is air a mixture or a compound? What proofs can you give for your statement?

EXPERIMENT 8.

To show the Presence of Carbon Dioxide and Water Vapor in the Air.

First Principles of Chemistry, Chapter XIX.

MATERIALS. Lime-water, beaker, bottles, candle, splint, paper, test-tube, long glass elbow.

(A) The Test for Carbon Dioxide in the Air.

Pour some clear lime-water into a beaker and allow it to stand in the air for an hour. Examine it. What change has occurred? What caused the change? Name the substances that formed.

(B) To show Some of the Sources of the Carbon Dioxide of the Air.

1. Exhale through the glass elbow into a test-tube containing a little lime-water. Describe and explain the result.

2. Lower a lighted candle into a bottle and allow it to burn a few minutes. Remove the candle, pour a little lime-water into the bottle, and shake vigorously. Describe and explain the result.

3. Allow a piece of wood to burn for a short time in a bottle. Remove the wood, pour a little lime-water into the bottle, and shake vigorously.

4. Repeat, using a piece of paper.

What other sources of the carbon dioxide of the air can you suggest?

(C) To show the Presence of Water Vapor in the Air.

MATERIALS. Calcium chloride, concentrated sulphuric acid, stick potassium hydroxide and sodium hydroxide.

1. Place a little of each of the three solids on a glass plate and leave it exposed to the air for twenty-four hours. What change occurs? What is the cause? Of what use may these solids be?

2. Pour exactly 10 cubic centimeters of concentrated sulphuric acid into a graduate, paste a label on the tube showing the date and number of cubic centimeters. Allow it to stand in the air until the end of the school year. Examine it from time to time and report the change.

What is a drying agent?

3. What other proofs can you give for the presence of water vapor in the air?

EXPERIMENT 9.

Ventilation.

First Principles of Chemistry, page 173. Dodd's Chemistry of the Household.

MATERIALS. Concentrated hydrochloric acid, concentrated ammonia, evaporating-dishes, yardstick.

1. Close all doors and windows.

2. Pour into an evaporating-dish some concentrated ammonia and into another dish some concentrated hydrochloric acid.

3. Bring the two dishes near together. What is the effect?

4. Place the dishes near the openings of a ventilating shaft. What course do the fumes take?

5. Draw a diagram of the room and indicate by arrows the course of the moving air as demonstrated by the fumes as the dishes are carried about the room.

6. Open the windows and doors and move about the room.

7. Does the moving air take the same course as before? Make a diagram.

8. Do the open windows help or retard the ventilation of the room when a ventilating plant is in action? How do they affect the ventilation of a room heated by a furnace, stove, or grate? What is the effect of opening the window from both top and bottom?

9. Of what use is a transom above a door?

The average amount of carbon dioxide in the atmosphere is .04 per cent; .06 per cent is limit allowable in air contaminated by respiration. Carbon dioxide is not con-

sidered poisonous, but it accompanies poisonous organic matter exhaled from the lungs.

The average amount of carbon dioxide exhaled per person per hour is .6 cubic feet; therefore, 3000 cubic feet of fresh air per person per hour must be admitted to living rooms to keep the carbon dioxide within the limit allowable.

10. Measure the recitation room and the sleeping rooms and living rooms at home and calculate the number of times per hour the air should be changed.

3. WATER.

EXPERIMENT 10.

Study of Hydrogen.

First Principles of Chemistry, Chapter IV.

MATERIALS. Granulated zinc, dilute sulphuric acid, pneumatic trough, flask, rubber stopper with two holes, safety-tube, delivery tube, test-tubes, one large bottle, splint.

1. Carefully slip a few pieces of zinc into the flask, insert the stopper, and pour through the safety-tube enough dilute sulphuric acid to barely cover the zinc. (See Fig. 6.) Collect the gas evolved by displacement of water, after allowing the air of the flask to pass out into the room.

2. Fill three test-tubes with the hydrogen, when you are sure that it is free from air, and quickly cork them. Then fill the large bottle with hydrogen and let it remain inverted over the water until it is needed.

3. Uncover for an instant a test-tube of hydrogen, so as to let in a little air, and then quickly bring it near the Bunsen flame. What is the result?

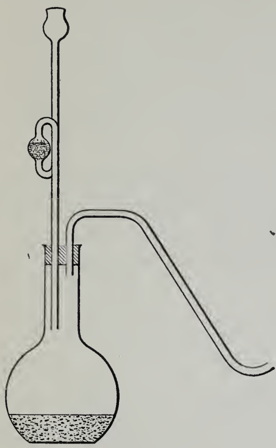


Fig. 6.

4. Remove the cork from another test-tube of hydrogen and allow it to remain uncovered for three minutes by the clock. Then show the presence of hydrogen by bringing the tube near the flame. Describe the result. What property of hydrogen is shown by this experiment?

5. Verify your answer to the last question thus: Hold a test-tube of air over a test-tube of hydrogen, mouth to mouth; use tubes of same diameter. Hold them there for a minute or two, then quickly bring each near the flame. What has become of the hydrogen? How does 5 verify 4?

6. Cover the large bottle with a glass plate; keep it mouth downward (why?) and carry it to the instructor.

Hold the bottle at arm's length and quickly remove the plate *just* at the moment a blazing splint is ready to be introduced into the bottle. Withdraw the splint and then insert it again yourself (Fig. 7).

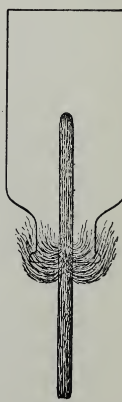


Fig. 7.

Does the hydrogen burn? If so, where? Does the splint burn when in the bottle? When out of the bottle? Feel the neck of

the bottle. Describe and explain. What three properties of hydrogen are shown by this experiment?

7. Pour the contents of the flask into a beaker and set aside. Examine the contents of the beaker. What are the crystals? What has become of the zinc? Of the sulphuric acid? What kind of change has taken place?

EXPERIMENT 11.

Study of Water. — Electrolysis.

First Principles of Chemistry, page 26.

MATERIALS. Hoffmann apparatus, sulphuric acid, splint.

1. Fill the Hoffmann apparatus with water containing 10 per cent of sulphuric acid, so that the water in the reservoir tube stands a short distance above the gas tubes after the stop-cock in each has been closed. Connect the platinum terminal wires with a battery. Allow the current to operate until the smaller volume of gas is from 8 to 10 centimeters in height. Measure the height of each gas column.

2. Test the gases as follows:

(*a*) Hold a glowing splint over the tube containing the smaller quantity of gas. What is the gas?

(*b*) Open the other stop-cock to force out the water in the glass tip, then hold a lighted match at the end of the tip. What is the gas?

3. What does this experiment show about the composition of water? What is the use of the sulphuric acid?

EXPERIMENT 12.

Study of Water. — Decomposition by Chlorine.

First Principles of Chemistry, page 61.

MATERIALS. Graduated tube with stop-cock, or a plain tube, corks, chlorine water with wide-mouthed bottle, pink and blue litmus paper, chlorine generator, water.

1. Heat very gently a mixture of concentrated hydrochloric acid and potassium chlorate crystals and collect the gas evolved in water. This solution is called "chlorine water."

What is the color of the gas? Odor? Of the solution in water?

2. Fill the graduated tube with chlorine water and invert it over the bottle of chlorine water. Have the bottle covered with cardboard. Test the chlorine water in the bottle with litmus paper of both colors. Now set the apparatus in the direct sunlight. Leave until next day.

3. When sufficient gas for a test has collected, close the stop-cock, remove the cork, and quickly introduce a glowing splint into the gas. Put litmus paper of both colors into the liquid of the tube and bottle.

(*a*) What was the effect of the chlorine water on litmus?

(*b*) What were the bubbles that rose in the tube?

(*c*) What gas collected in the tube?

(*d*) What is the action of the remaining liquid on litmus paper?

(*e*) What is the color of the liquid?

(*f*) What substances change litmus as the remaining liquid does? What does it, therefore, seem to be? What is its name?

(*g*) What does this experiment teach about the composition of water?

(*h*) What made it possible for the chlorine to decompose the water?

EXPERIMENT 13.

Study of Water. — Synthesis.

First Principles of Chemistry, pages 30, 31.

MATERIALS. Hydrogen generator, calcium chloride tubes, platinum jet, bell-jar, hard glass tube, black copper oxide, anhydrous copper sulphate.

(A) Synthesis of Water by Burning Hydrogen.

1. Connect a calcium chloride tube with a hydrogen generator. All joints must be air tight. Attach a delivery tube to the calcium chloride tube, and collect a test-tube full of hydrogen by displacement of water.

2. If it burns quietly, remove the delivery tube and attach the platinum jet.

3. Allow the hydrogen to pass for a full minute, and then hold a bell-jar over the tip (Fig. 8). Note any change.

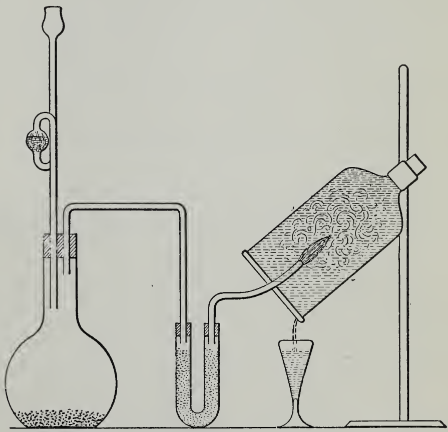


Fig. 8.

4. Remove the jar and light the hydrogen and again hold the bell-jar over the jet. Note any change in the jar.

(*a*) How is the hydrogen generated?

(*b*) Of what use is the calcium chloride tube?

(*c*) Why was the hydrogen tested before the jet was attached?

(*d*) Will hydrogen burn in air at ordinary temperatures? How do you know?

(*e*) What is produced by the combustion of hydrogen? What proof have we?

(*f*) What is the meaning of "synthesis"?

(*g*) How does this experiment show the composition of pure water?

(B) Synthesis of Water by the Reduction of Copper Oxide.

1. Arrange a train of apparatus, consisting of a hydrogen generator, a calcium chloride tube, a hard glass tube, and another calcium chloride tube (Fig. 9). Make all

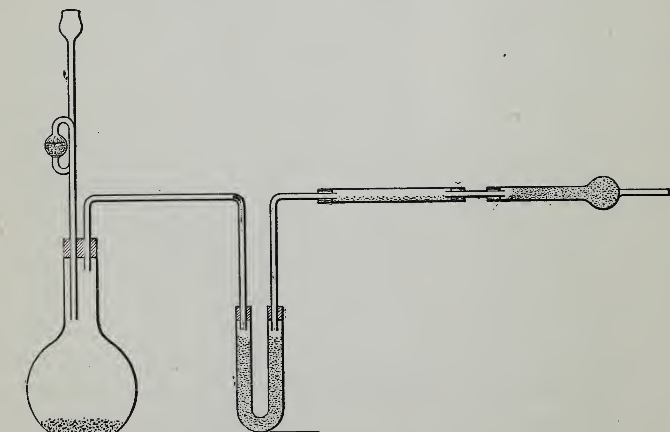


Fig. 9.

connections hydrogen tight. Partly fill the first calcium chloride tube with granular calcium chloride, place a layer of black copper oxide in the hard glass tube, and a little anhydrous copper sulphate in the last calcium chloride tube. Generate the hydrogen by the union of zinc and sulphuric acid.

2. Allow the hydrogen to pass through the train a few minutes, then heat the hard glass tube.

(*a*) What change do you notice in the copper oxide tube? In the anhydrous copper sulphate? Explain. What forms on the cool surface of the last calcium chloride tube?

(*b*) Why is hydrogen called a reducing agent? What does this experiment teach about the composition of water? How does it illustrate synthesis?

EXPERIMENT 14.

General Distribution of Water.

First Principles of Chemistry, Chapter VI.

MATERIALS. Wood, meat, potato, other fresh vegetables, gypsum, copper sulphate, sodium carbonate, alum, zinc sulphate crystals.

1. Heat successively in old, dry test-tubes a small piece of wood, of meat, of potato, and of other vegetables. Hold the open end of the test-tube lower than the other end. Why? Is there evidence of water?

2. Heat successively in old, dry test-tubes a few crystals of sodium carbonate, of gypsum, of copper sulphate, of alum, and of zinc sulphate.

(*a*) Note the changes that occur in the crystals. What gave these crystals their form?

(*b*) Not all crystals contain water. Many do not. Name some that do not. How could you prove it?

(*c*) How is the water held in the vegetables?

(*d*) How is it held in the crystals?

EXPERIMENT 15.

Simple Tests for Impurities in Water.

First Principles of Chemistry, pages 41, 42.

MATERIALS. Distilled water, city water, water containing dirt, a sulphate, a chloride, a calcium compound, solutions of potassium permanganate, barium chloride, silver nitrate, ammonium oxalate, sulphuric acid.

(A) Organic Matter.

1. Half fill a clean test-tube with distilled water, another with city water, and a third with distilled water containing a little dirt or a bit of paper.

2. Add to each test-tube a drop or two of concentrated sulphuric acid and sufficient potassium permanganate solution to color each liquid a light purple, as nearly alike as possible.

3. Heat each tube nearly to the boiling point.

(*a*) In which tube is the potassium permanganate decolorized?

(*b*) Does the city water contain organic matter?

(B) Chlorides.

1. Fill a clean test-tube half full of distilled water, another with city water, and a third with distilled water containing a little common salt, sodium chloride.

2. Add to each tube a few drops of silver nitrate solution.

(*a*) In which tube does a precipitate appear? It is called silver chloride. Silver chloride is soluble in ammonium hydroxide. Try it.

(*b*) Does the city water contain a chloride?

(C) Sulphates.

1. Fill a test-tube half full of distilled water, another with city water, and a third with distilled water containing a little zinc sulphate.

2. Add to each tube a little barium chloride solution.

(*a*) In which tube does the cloudiness or white solid appear? This precipitate is barium sulphate. It is insoluble in all common liquids and is always found when barium chloride is added to sulphuric acid or a sulphate in solution.

(*b*) Does the city water contain a sulphate?

(D) Calcium Compounds.

1. Fill a test-tube half full of distilled water, another with city water, and a third with distilled water containing a little calcium hydroxide. This solution is called lime-water.

2. Add to each tube a little ammonium oxalate solution.

(*a*) In which tube does a white precipitate appear? It is called calcium oxalate. Calcium oxalate is not soluble in acetic acid, but it is soluble in hydrochloric acid.

3. Test the solubility of the white precipitate in this way. Shake the test-tube well to distribute the particles of the precipitate, divide this milky liquid into two parts, and add acetic acid to one part and hydrochloric acid to the other. Which acid clears the solution?

4. Make a table showing the name and formula of each testing agent and the names, formulas, form, and color of the compounds produced by the reactions.

EXPERIMENT 16.

Distillation — A Means of Purifying Water.

First Principles of Chemistry, page 41.

MATERIALS. Flask, thermometer, condenser, potassium permanganate, city water, solutions used in Experiment 15.

1. Fill the flask half full of water; add a few cubic centimeters of potassium permanganate. Insert the ther-

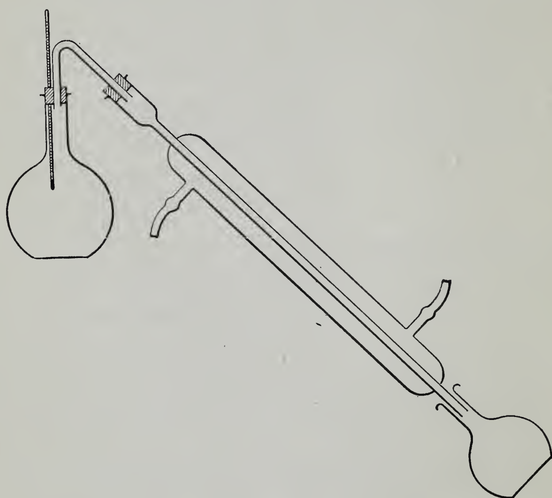


Fig. 10.

mometer and connect the condenser (Fig. 10). Attach the inlet tube to a faucet, fill the condenser slowly, and regulate the currents so that a small stream flows continually from the outlet tube into the sink. Heat the liquid in the flask gradually and note the temperature at

which a distillate collects in a receiver placed at the end of the condenser.

(*a*) Test separate portions of the distillate for organic matter, chlorides, sulphates, and calcium compounds.

(*b*) Why does the distillate not contain potassium permanganate?

2. Boil a mixture of alcohol and water and condense the vapor. Is the distillate pure water? Explain.

(*a*) When would it not be profitable to distil water?

(*b*) Upon what does the value of distillation depend?

3. Examine a commercial still and make a drawing of its parts. Why is it more economical than the kind used in this experiment?

EXPERIMENT 17.

To show the Solvent Power of Water.

First Principles of Chemistry, page 43.

MATERIALS. Faucet water, ammonium hydroxide, concentrated hydrochloric acid, alcohol, kerosene, glycerine, carbon disulphide, powdered copper sulphate, powdered potassium chlorate, powdered calcium sulphate, sugar, starch, salt.

(A) Solubility of Gases.

Warm *very gently* in test-tubes a few cubic centimeters of faucet water, of ammonium hydroxide and of concentrated hydrochloric acid. Look for bubbles of gas on the sides of the test-tubes. What is escaping from each test-tube? Do not *boil* the liquids. Why not? How does increased temperature affect the solubility of gases? What gases dissolve freely in water?

(B) Solubility of Liquids. *Do not heat.*

1. To a test-tube one-half full of water, add a little alcohol and shake. Is there evidence of solution? Add a little more and shake. Allow the test-tube to stand several minutes and then see if the liquids have separated into layers.

2. Repeat 1 using successively kerosene, glycerine, and carbon disulphide.

3. Draw a conclusion as to the solubility of different liquids in water.

4. Summarize the results in a table.

(C) Solubility of Solids.

1. Fill six test-tubes one-third full of water. To the first add one gram of powdered copper sulphate and to the second exactly the same weight of powdered potassium chlorate, and so on, using the same weights of each of the solids named under Materials.

2. Shake the test-tubes and then allow them to stand undisturbed for a few minutes. Is there evidence of solubility in each case? Is there evidence of varying degrees of solubility? If you are in doubt, carefully transfer a portion of the clear liquid into an old clean test-tube and evaporate to dryness.

3. Heat each tube nearly to boiling and add four more grams of each solid. Do not boil the liquid away. What effect has increased heat on the solubility of solids? Of gases?

4. Heat again nearly to boiling and add the respective solids bit by bit, until the last tiny portion fails to dissolve. The solution is then said to be saturated.

5. Tabulate the results of **(C)** as follows, using the customary terms to express the degree of solubility:

TABLE OF SOLUBILITY.

	SOLUTE.	WATER AT TEMPERATURE OF LABORATORY.	WATER AT A HIGH TEMPERATURE.
1.	Copper sulphate		
2.			
3.			
4.			
	etc.		

4. FUELS AND ILLUMINANTS.

EXPERIMENT 18.

Carbon-distribution.

First Principles of Chemistry, Chapter XXIII, pages 227–230.

MATERIALS. Hessian crucible, wood, cotton, starch, sugar, paper, sand, cotton cloth, wool, candle, Bunsen burner, kerosene, vegetables, meat. *Note.* — An iron dish may be used instead of the clay crucible.

1. Cover the bottom of a Hessian crucible with a thin layer of sand; then add the materials named above, except candle, kerosene, and Bunsen burner. Cover these with another layer of sand and slip the crucible into the ring of the iron stand. Heat with a flame which extends just above the bottom of the crucible until the smoking ceases. After the crucible has cooled sufficiently to handle, pour the contents upon a tin pan. Examine the contents. What is the residue?

2. Heat a little sugar in an old test-tube. What are the most obvious products? Burn the gas that forms. What is it?

3. Treat a little sugar with a few drops of concentrated sulphuric acid and note the change in appearance. Explain.

4. Introduce a cold object, such as a splint, a piece of porcelain or of crayon, successively into a kerosene flame, a candle flame, and a Bunsen flame. What is deposited on the surface of the cold object? What element, therefore, must the kerosene, paraffine, and illuminating gas contain?

Compounds that contain this element are called organic compounds. Why?

EXPERIMENT 19.

Study of Amorphous Carbon.

First Principles of Chemistry, pages 230, 235, 238.

MATERIALS. Animal charcoal, wood charcoal, lamp black, indigo solution, dark brown sugar, ammonium sulphide, hydrochloric acid, sulphuric acid, water, nitric acid, ammonium hydroxide, filter paper, funnel, copper oxide, lime-water, graphite.

(A) Decolorizing Action of Charcoal.

1. Fill a test-tube one-fifth full of powdered animal charcoal; add 10 cubic centimeters of indigo solution; shake thoroughly and then warm gently. Filter through a wet filter-paper into a clean test-tube. Compare the color of the filtrate with that of the indigo solution. Explain the change.

2. Pour clean water through the charcoal left in the filter-paper and then pour through a strong solution of dark brown sugar. Animal charcoal is used in sugar factories. How?

(B) Deodorizing Action of Charcoal.

1. Smell some ammonium sulphide.

2. Fill a test-tube one-fourth full of powdered wood charcoal, add a little ammonium sulphide, and cork securely. Shake thoroughly. After fifteen or twenty minutes, remove the stopper and smell of the contents. Has the bad odor been removed?

Wood charcoal is used in sick-rooms. Why? Wood charcoal is also a good filtering agent. Why? Where is it used for this purpose?

(C) Charcoal as a Reducing Agent.

1. Mix together two grams of black copper oxide and about one-tenth its weight of powdered charcoal; heat in a test-tube which is fitted with a one-holed stopper and a long elbow. Pass the gas evolved into lime-water contained in a test-tube.

2. What change do you notice in the tube containing the copper oxide? In the lime-water? What has become of the charcoal? Explain the changes.

(D) Solubility of Amorphous Carbon.

1. Test the solubility of bone-black, wood charcoal, lampblack, and graphite in water, ammonium hydroxide, and the three common acids.

What uses of wood charcoal depend upon its insolubility?

EXPERIMENT 20.

The Union of Carbon and Oxygen.

First Principles of Chemistry, page 233.

MATERIALS. Bag of oxygen, hard glass tube, small pieces of charcoal, lime-water.

1. Pass oxygen from the bag over the charcoal, in the hard glass tube, into the lime-water.

Does the charcoal unite with oxygen at ordinary temperatures?

Does the oxygen unite with the calcium hydroxide in the lime-water?

2. Heat the hard glass tube carefully until the charcoal begins to glow; then pass oxygen from the bag over the charcoal. Remove the flame.

What gas passes into the lime-water?

Why does the charcoal continue to glow after the Bunsen flame is removed?

What is left in the hard glass tube?

Why does the charcoal produce no flame in combining with the oxygen?

Why is it better to burn coal than charcoal in our stoves?

Why is it dangerous to burn charcoal on a brazier?

EXPERIMENT 21.

Carbon Monoxide.

First Principles of Chemistry, page 249.

MATERIALS. Oxalic acid crystals, concentrated sulphuric acid, lime-water, pneumatic trough, vaseline bottles, flask, two-holed stopper, safety-tube, elbows, side-neck test-tube.

1. Heat very gently a mixture of oxalic acid crystals and concentrated sulphuric acid. (Use about half a teaspoonful of the crystals and enough of the sulphuric acid to cover them well.) Allow the gases evolved to pass slowly through lime-water contained in a side-neck test-tube. Collect the carbon monoxide by displacement of water.

2. Remove one vaseline bottle full of carbon monoxide and quickly pour into it a little clear lime-water. Shake well, keeping the glass plate fast over the mouth of the bottle.

3. Remove the cover from another vaseline bottle full of gas and bring a lighted splint near the mouth of the bottle. Put the blazing splint into the bottle. Result?

Of what use is the concentrated sulphuric acid? The lime-water? What change takes place in the lime-water? Does the carbon monoxide burn or support combustion? Does it unite with calcium hydroxide? How do you know?

By what other methods have you prepared carbon monoxide?

What causes the blue flame that often appears over a hard-coal fire?

Make a table showing the difference between the two oxides of carbon.

EXPERIMENT 22.

Study of Flames.

First Principles of Chemistry, pages 238-241.

MATERIALS. Candle, Bunsen burner, squares of cardboard, bottle of lime-water, white paper, splint, long glass elbow, charcoal dust, iron dust, wire screens, alcohol.

(A) Candle Flame.

1. Examine a candle flame, noting all the parts with the colors of each. Make a drawing to illustrate. Hold it in front of a blackboard to see the outer portion; also place it in direct sunlight and examine the shadow cast on white paper. How many cones can you see?

Fig. 11.

2. Press quickly down upon the candle flame with a piece of cardboard and remove it at once. Where is the cardboard charred? What does this teach about the temperature of the inner cone? Which part of the flame is the hottest? What causes the heat? What gives color to the flame?

3. Hold a cold, dry bottle over the lighted candle. What forms inside the bottle? Remove the bottle and quickly pour a little clear lime-water into it and shake. What is the result?

4. Blow out the flame and quickly hold a lighted match in the escaping smoke. Does the candle relight? What is the smoke? Examine the little cup formed on the top of the candle after it has been burning for some time. What is the liquid? What is the candle wax?

(B) Bunsen Flame.

1. Examine a Bunsen flame in the same way, and make a drawing.

2. Hold a small splint across the lower part of the flame, just above the lamp, for a moment. Remove it and note where it is burned.

3. Hold it just above the inner cone and note again.

4. Put one arm of a long glass elbow in the inner cone, just above the lamp tube, and try to light the gas at the end of the other arm.

5. Gradually raise the arm in the flame until it is in the second cone and note the effect.

6. See whether there is any inward suction or outward pressure of air or gas at the lower orifices.

7. Examine a dissected burner, *i.e.* one with the tube removed; notice the opening for gas and light the gas.

8. Press quickly down on the Bunsen flame with a piece of heavy cardboard; remove quickly before it burns and note the part that is charred most. What does it show?

9. Sprinkle a pinch of charcoal dust in the flame. Note the effect. Explain.

10. Scrape a little iron-rust into the flame.

11. Stir up the dust near the flame.

12. Close the orifices at the base. Explain the results in 10, 11 and 12.

13. Light a Bunsen flame and press down with a fine wire gauze to 3 or 4 centimeters above the burner (Fig. 12 *a*).

14. Extinguish the flame, then relight the gas *above* the gauze (Fig. 12 *b*) and gradually lift the gauze till the gas will not burn.

15. Again light the gas above the gauze and hold another gauze above the flame, so as to confine it above and below. What do 13, 14, and 15 teach?

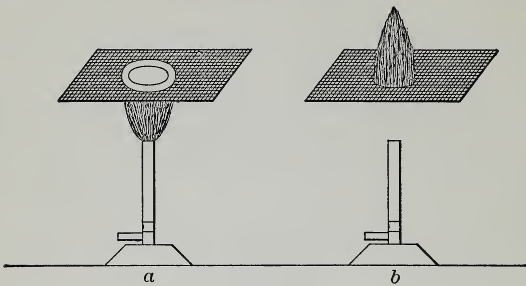


Fig. 12.

Why does carbon not burn with a flame?

What causes the color in the Bunsen flame when the orifices are closed?

Why is the flame, as we use it, not luminous? What is illuminating gas?

How can any colorless flame be made to have color?

What is meant by "kindling temperature"?

(C) Alcohol Flame.

1. Examine an alcohol flame and make a drawing. What is alcohol?

2. Determine which part of the flame is hottest.

Which of the three flames studied produces the most light? Which produces the greatest heat? Which makes, therefore, the best fuel? What is denatured alcohol? Its uses?

EXPERIMENT 23.

Common Gaseous Hydrocarbons.

First Principles of Chemistry, pages 179, 251, 377-379.

MATERIALS. Calcium oxide, solid sodium hydroxide, fused sodium acetate, hard glass tube, delivery tube, corks, pneumatic trough, vaseline bottles, large test-tube, one-holed stopper, elbow, water, calcium carbide, aluminum carbide, soft coal, clay pipe, plaster of Paris.

(A) Methane, or Marsh Gas.

1. Fuse some sodium acetate crystals.

Mix the fused mass with calcium oxide and sodium hydroxide, solid, and grind well in a mortar. Cork securely one end of a hard glass tube; put into the tube enough of the mixture to half fill it as it lies in a horizontal position; insert the cork with the delivery tube at the other end.

2. Heat gently and collect the gas evolved by displacement of water.

3. Test the gas with a match or blazing splint. What is the color of the flame? What are the products of combustion? How can we determine this?

4. Prepare methane by the union of aluminum carbide and water in a test-tube. What does this suggest as to the possible source of methane in nature?

Where does methane occur in nature? How is it made commercially? What are its uses?

(B) Acetylene Gas.

1. Fill a test-tube one-half full of water, stand the tube in a rack, and drop two or three very small pieces of cal-

cium carbide into the test-tube; then quickly insert the stopper with glass elbow, or a tube bent to form a jet. As soon as the acetylene has forced the air out of the tube, light the gas by holding a lighted match at the end of the elbow. Observe and record the nature of the flame, especially its color, intensity, visible products, temperature, etc. Hold a glass plate or cold dish over the flame. What does the result suggest about the composition of acetylene? What other evidence of its composition is shown by the properties of the flame? How is acetylene manufactured? How is it used?

(C) Illuminating Gas.

Place some pulverized soft coal in the bowl of a clay pipe; seal the top with plaster of Paris. Heat carefully. Note the fumes that escape. Will they burn? What does this suggest concerning the manufacture of illuminating gas? What useful substances are made from the destructive distillation of soft coal? Why may the gas not be sent from the retorts to the gas tank holders?

EXPERIMENT 24.

Study of Some Liquid Hydrocarbons.

First Principles of Chemistry, page 376.

MATERIALS. Naphtha, gasoline, benzine, kerosene, paraffin, butter, iron-rust, mutton tallow, litmus paper, watch-glasses, evaporating-dish, test-tubes, glass rod.

1. Pour not more than twenty drops of each liquid into a clean, dry, wide-mouthed bottle; stir the vapor with a

hot glass rod; withdraw the rod and apply a light. Note the result.

2. Pour the same quantity of the liquid into an evaporating-dish and immediately apply a flame. Note the result and explain the difference in the two phenomena.

3. Pour about a teaspoonful into a large test-tube; add an equal bulk of water, cork and shake well; allow the test-tube to rest for a few minutes in a cool place. What happens? What kind of liquid is it?

4. Pour twenty drops of each liquid into a flat watch-glass; allow it to stand, and note the time of evaporation and quantity of residue, if any.

5. Try the action of each on both kinds of litmus paper.

6. Test the solubility of paraffin, butter, iron-rust, and mutton tallow in each liquid.

What is meant by the "flashing point" of kerosene?

5. THE NATURE OF COMMON SUBSTANCES.

EXPERIMENT 25.

A Study of Acids.

First Principles of Chemistry, pages 116, 117.

MATERIALS. Sulphuric acid (2 : 1), sodium chloride, sodium nitrate, sodium acetate, and sodium carbonate, pink and blue litmus paper, zinc, iron filings, splints, long glass elbow, corks, test-tubes.

(A) Preparation from Sulphuric Acid and a Salt.

1. Put a little sodium chloride into a test-tube, attach a long elbow by means of a cork; add a little dilute sul-

phuric acid, cork quickly, and pass the gas evolved into a few cubic centimeters of water in another test-tube. Heat gently if the action is too slow. Cork the solution and set it aside. Repeat the process, using the other salts.

2. Collect some of each acid formed in a dry test-tube, surrounded by cold water, cork, and set aside.

3. Remove the cork from the generator test-tube, heat gently, and at the same time introduce a blazing splint into the mouth of the tube. Do acids burn? Do they support combustion?

4. Hold a piece of blue litmus paper in the gas that comes from the generator. How do acids affect litmus?

5. What is the form of the acid in each cool dry test-tube? Slip a piece of moist blue litmus paper into each dry tube.

6. Cautiously taste the solution of each acid. Describe. Test with litmus. Result?

7. Slip a few iron filings into one-half of each solution and a few small pieces of zinc into the other half. How do acids act with metals? Cork each tube, and after a few minutes test for hydrogen the gas formed.

8. Describe the color of the acids — their odor.

9. Write the names and formulas of six acids that are gases at ordinary temperatures, four that are liquids, and four that are solids. Which of these acids are called "organic"? Why?

10. Name the acids that are most useful and tell how they are used.

EXPERIMENT 26.

A Study of Bases.

First Principles of Chemistry, pages 105, 116.

MATERIALS. Sodium carbonate, milk of lime, copper sulphate solution, zinc sulphate, ferric nitrate, potassium hydroxide solution, ammonium hydroxide, litmus.

(A) Preparation of a Soluble Base.

1. Dissolve a few crystals of sodium carbonate in a little water, add milk of lime, stir well; heat and stir until a few drops of the clear liquid that forms on the surface do not effervesce when hydrochloric acid is added. What chemical changes have taken place? Pour off the clear liquid and set it aside. Keep the remaining solid.

2. Will the solid dissolve in water? Can it be the original sodium carbonate?

3. Rub some of the clear liquid between the fingers. What is it?

4. Test a portion with litmus paper of both colors.

5. Try to remove a grease spot with a portion.

6. Cautiously taste a little.

7. Add some of the solution to a little ferric nitrate solution. Result?

8. Add the remainder of the solution to a very dilute solution of hydrochloric acid until there is no effect on either pink or blue litmus paper. Boil the liquid to dryness. What is the solid left? Taste it.

9. Make a summary of the properties of sodium hydroxide. In what form is it purchased for laboratories? How is it used?

(B) Preparation of an Insoluble Base.

1. To a little copper sulphate solution in a test-tube add a little potassium hydroxide solution. Describe the result. Repeat, using sodium and ammonium hydroxides.

2. Treat a little zinc sulphate and a little ferric nitrate in the same way and describe the results.

What is the precipitate formed in each case? What kind of substances formed it? How may bases be made?

3. Write the names, formulas, and colors of three bases that are very soluble, two that are slightly soluble, and six that are insoluble in water.

EXPERIMENT 27.

A Study of Salts.

First Principles of Chemistry, page 68.

MATERIALS. Potassium hydroxide, nitric acid, iron filings, sulphuric acid, evaporating-dish, litmus paper, beaker.

(A) Preparation from a Base and an Acid. Neutralization.

1. Pour about 5 cubic centimeters of potassium hydroxide into an evaporating-dish and slowly add nitric acid, while stirring, until neither kind of litmus paper is changed by the liquid. Show the neutral solution to the instructor.

2. Heat gently until a solid appears around the edges, then pour into a beaker and set aside to crystallize.

3. Note the form, color, taste, solubility, and action of papers in a weak solution of these crystals.

What is the name of the new substance?

Why is the process called neutralization?

(B) Preparation from a Metal and an Acid.

1. Add a little sulphuric acid to some iron filings in a test-tube. Cork. Later, test with a lighted match the gas evolved. What does it seem to be? When most of the iron filings have disappeared, pour off the clear liquid into an evaporating-dish and heat until a solid appears around the edge; then set aside to crystallize.

2. Note the form, color, and solubility of these crystals. What is the name of the new substance? Its formula? Test a dilute solution with litmus papers.

3. Test the action of litmus papers in dilute solutions of five common salts and report your observations. Conclusion?

In Experiments 25, 26, and 27, we have prepared salts in four different ways. What are the ways?

4. Test very concentrated solutions of borax, sal soda, common salt, and blue vitriol with litmus. Write the chemical name and formula for these salts.

What is the form and color of most salts?

PART II.

SIMPLE ORGANIC CHEMISTRY.

How to provide wholesome, nutritious food, at a moderate cost, deeply concerns every housewife. It is fitting, therefore, that the study of *foods* should constitute a large part of a course in chemistry for girls.

The object of Part II is to teach the composition of foods, through a study of food principles; to give a knowledge of special foods, and their dietetic values; of food adjuncts, and food adulterants, and to introduce the study of textiles.

The carbohydrates are chosen for first consideration on account of their relative simplicity and common use in practically a pure state.

As there is no high school text-book in chemistry covering all the ground of Part II, the material for study must be obtained from many sources. A number of these are named in the Appendix. References are given with each experiment to sections in "References for Class Study" of the Appendix.

It is possible to do good work with the aid of three or four of the books given in the Bibliography. The choice may be made from those indicated by a double star. The books less frequently needed are marked with a single star. Those not marked make good supplementary reading. The bulletins which may be obtained, free, from the U. S. Department of Agriculture should be in constant use.

The difficulties arising from the use of a few books by a large number of students may be lessened by dividing the class

into groups and assigning to each group a certain portion only of the lesson. For example, in the study of starch, one group may prepare the topic, "Occurrence of Starch"; another, "The Preparation for Market"; a third, "The Properties," and so on. The books could thus be passed quickly from group to group.

The special foods mentioned in Section 19 of "References for Class Study" of the Appendix should be studied in connection with the review of the food principles of which they are largely composed.

The food charts and exhibits are most instructive and interesting.

6. FOODS.

EXPERIMENT 28.

To determine the Amount of Water in Foods.

Appendix, References for Class Study, Section 1.

Materials. Potatoes, bread, balances.

(A) Percentage of Water in Potatoes.

1. Weigh a potato that has not been peeled and leave it in a warm, dry place for four days. Then weigh and determine the per cent of water lost.

2. Repeat the process in 1, using a peeled potato. What is the use of the peel?

3. Weigh another peeled potato and heat it very carefully in an oven until it is completely dried. Weigh and determine the per cent of water lost.

(B) Percentage of Water in Bread.

Repeat 1 and 3 of **(A)**, using a slice of home-made bread and one of baker's bread.

Record all results in tabular form.

EXPERIMENT 29.

Starch.

First Principles of Chemistry, pages 246, 392. Appendix, References for Class Study, Section 2.

MATERIALS. Corn-starch, potato starch, water, iodine solution, foodstuffs, sulphuric acid.

(A) Method of Applying Iodine Test.

1. Put a small amount of corn-starch in a test-tube, add water, and shake the mixture. Does the starch dissolve? How do you know? Let the mixture stand.

2. Boil the mixture. What change do you notice? Explain.

3. Add one or two drops of iodine solution to a few cubic centimeters of the cool paste. Result? Boil. Result?

4. Add a few drops of starch paste to a large glassful of cold water; stir in a few drops of iodine. Result?

5. Pour a little iodine solution into a test-tube of water. What do you observe?

(B) Application of Iodine Test.

Test as many foods as you can, as follows:

1. Boil the food in water. Why?

2. Cool and add a few drops of iodine.

Why should the food cool before the iodine is added?

Tabulate your results under the following heads:

MUCH STARCH	LITTLE STARCH	NO STARCH

(C) Properties of Starch.

1. Recall the action of cold water and of hot water upon starch.

2. Carefully heat a little starch powder in a dry test-tube or in an oven. Compare the taste of the heated starch with that of a browned crust of bread. How is the starch of the bread crust changed during the baking of the bread?

3. Burn a little starch in a free flame.

4. Add a few drops of concentrated sulphuric acid to a little dry starch. What change does the acid produce? Explain. What do 3 and 4 teach concerning the composition of starch?

a, Potato Starch; b, Corn Starch.
(*Much magnified.*)
Fig. 13.

5. Boil a little dilute starch paste with a few cubic centimeters of dilute sulphuric acid; boil cautiously for several minutes, then pour the solution into a clean bottle and keep it for use in Experiment 30.

6. Examine grains of corn-starch and of potato starch with a microscope.

EXPERIMENT 30.

Sugars.

First Principles of Chemistry, pages 392-394. Appendix, References for Class Study, Section 3.

MATERIALS. Grape-sugar, cane-sugar, sulphuric acid, copper sulphate, Rochelle salt, sodium hydroxide, compressed yeast, starch solution prepared in Experiment 29, raisins, honey, potato, and other foods.

(A) Grape-sugar and Cane-sugar.

Compare the two sugars, noting:

1. The form and general appearance.
2. The taste.
3. Solubility in cold water.
4. Solubility in hot water.
5. The effect of moderate dry heat.
6. The effect of strong dry heat.
7. The effect of burning in a free flame.
8. The effect of concentrated sulphuric acid on the solid.
9. The action of compressed yeast on a warm dilute solution of each.

Leave the mixtures in a warm place for twenty-four hours.

What change do you see? What do 6, 7, and 8 teach about the composition of sugars?

(B) Fehling's Test for Grape-sugar.

1. Preparation of Fehling's solution.

Pour 5 cubic centimeters of copper sulphate solution into a large test-tube, add 5 cubic centimeters of Rochelle

salt solution and enough sodium hydroxide solution to dissolve the precipitate which appears. The mixture should be strongly alkaline. Boil it. No change should occur.

2. Add a little of the Fehling's solution to a solution of grape-sugar and boil. Cuprous oxide, red, should form as a precipitate.

3. Repeat 2, using cane-sugar solution. What difference do you note?

4. Boil for several minutes a solution of cane-sugar with a few cubic centimeters of dilute H_2SO_4. Neutralize the excess of acid with sodium carbonate, then add Fehling's solution and boil. What appears? How has the acid changed the cane-sugar?

5. Add sodium carbonate to the mixture of starch paste and H_2SO_4 boiled in Experiment 29, in order to neutralize the excess of acid; then add Fehling's solution and boil. How is starch changed by boiling in acids? What commercial use is made of this property?

(C) Application of Fehling's Test to Foods.

Boil a portion of each food in a little water; add Fehling's solution and boil. Tabulate your results thus:

Grape-sugar Present	Grape-sugar Absent

EXPERIMENT 31.

Digestion of Starch.

First Principles of Chemistry, page 392. Appendix, References for Class Study, Section 2.

MATERIALS. Corn-starch, saliva, pancreatin solution.

(A) By Saliva.

1. Put a small amount of corn-starch in a test-tube, add water, and boil; dilute the paste until a smooth, thin mixture is formed.

2. Test a small portion of this mixture with Fehling's solution. Result? Conclusion?

3. Test some clear saliva with Fehling's solution.

4. Mix some saliva with starch paste, shake the mixture, stand the tube containing it in warm water. After a few minutes, test with Fehling's solution.

5. Hold a small amount of boiled dilute starch paste in the mouth. What is the taste at first? Do you notice any change? What causes it? What is the effect of saliva on boiled starch? Name several foods that could be partially digested by saliva.

(B) By Pancreatic Juice.

1. Dissolve a little pancreatin in a few cubic centimeters of luke-warm water. Test a portion with iodine. Result?

2. Add some pancreatin solution to a few cubic centimeters of dilute starch paste. Set the tube containing the mixture in a pail of warm water (temperature 98° F.), and place the pail in a fireless cooker. Remove it at the

end of twenty-four hours and test for the presence of starch with iodine.

What digestive juices of the human body act upon starch?

What changes do they cause?

EXPERIMENT 32.

Cellulose.

First Principles of Chemistry, page 390. Appendix, References for Class Study, Section 4.

(A) Examine the cellulose fibres of pure filter paper, of cotton, celery, turnips, and other vegetables, under a compound microscope.

(B) 1. Test the solubility of the substances used in **(A)** in water, dilute sulphuric acid, dilute hydrochloric acid, and dilute caustic soda.

2. Try the action of concentrated sulphuric acid on paper and cotton.

3. Dissolve a little black copper oxide in concentrated ammonium hydroxide. The deep blue solution formed is called Schweitzer's reagent. Try the solubility of cotton and paper in this.

4. Test the solubility of cellulose in a strong solution of zinc chloride.

5. Test cellulose with iodine.

6. Test cellulose with Fehling's solution. What would you conclude about the digestibility of cellulose? What is its value in foods? How is it used commercially?

EXPERIMENT 33.

Gums — Resins — Varnishes.

Appendix, References for Class Study, Section 5.

MATERIALS. Gum arabic, agar-agar, shellac, rosin.

(A) Study of Gums.

1. Examine the gums carefully. Put a small amount of each into an old dry test-tube and heat in the Bunsen flame. Compare the result with the effect of heat upon starch and sugar. What do you conclude the composition of gums to be?

2. Dissolve a little of each in warm water; let the solution cool. Result?

3. Try to dissolve the gums in alcohol.

4. Try the action of Fehling's solution on a portion of the dissolved gum. Result?

5. Boil a water solution of the gums with dilute sulphuric acid. Again test with Fehling's solution. Explain.

Of what use are these gums? Are they ever used in the preparation of foods? What foods? Why?

(B) Study of Resins.

1. Repeat **(A)** 1, using the resins given you.

2. Try to dissolve each in water.

How do resins compare in this respect with gums?

3. Try to dissolve each in sodium hydroxide. Put some of the dissolved substance upon a pine splint and let it dry. Result? Such a solution is called a "water varnish."

4. Try to dissolve each in alcohol. (Warm gently, so that the alcohol may not catch fire. Have a cloth ready to

smother the flame.) Such solutions colored with dyes are called "spirit varnishes."

Coat another pine splint with some of this substance and allow it to dry.

Notice that it dries quickly, leaving a brilliant film, which is very brittle and liable to crack and scale off.

5. Repeat (**B**) 4, using turpentine as the solvent. Such a solution is called a "turpentine varnish." Coat a stick as before.

Notice that this varnish dries much more slowly than the spirit varnish, but that the film is tough and will not scale.

6. Repeat (**B**) 4, using linseed oil as the solvent. Apply to a stick as before. Linseed oil varnish may consist of linseed oil alone, which gives a very hard surface, or it may be a resin dissolved in linseed oil. Such a varnish gives a very hard and brilliant surface.

Of what use are the four varnishes?

How could you distinguish them?

Chemically, what are they?

EXPERIMENT 34.

Nitrogenous Substances.

First Principles of Chemistry, pages 167, 195, 228. Appendix, References for Class Study, Section 6.

MATERIALS. White of egg, milk, meat, concentrated nitric acid, ammonium hydroxide, peas, beans, and other foods.

(A) Effect of Heat.

1. Pour a small amount of the white of an egg into a test-tube. Place a chemical thermometer in the egg and

hold the tube in a beaker of cool water. Gradually heat the water, stirring continually with the test-tube.

At what temperature does the egg change its appearance? How is albumen affected by heat?

2. Gently heat some milk in a pan. Remove the scum that appears. Continue the heat, removing the second scum that forms. What are these scums?

3. Cook a small piece of meat in a pan. How does the heat affect its outer surface? What is your conclusion about its composition?

(B) Smell when Burning.

1. Burn a piece of meat in a free flame. Have you ever noticed this smell before? If so, what caused it?

2. In the same way, test peas or beans.

(C) Effect of Nitric Acid and Ammonia.

1. Pour a little concentrated nitric acid on a piece of hard-boiled white of egg. What do you observe?

Wash off the egg with water; add a little concentrated ammonia. Result?

2. Test, with a drop of nitric acid, the skin on the tip of one of your fingers.

3. Apply the nitric acid and ammonia test to as many foods as you can.

Tabulate your results under the following heads:

Nitrogenous Substances Present	Nitrogenous Substances Absent

EXPERIMENT 35.

Special Proteids.

First Principles of Chemistry, pages 167, 228. Appendix, References for Class Study, Section 6.

MATERIALS. Albumen, gluten, casein, legumin, myosin.

(A) Albumen.

Note the properties of the white of egg, *i.e.* form, color, odor, taste, solubility in H_2O.

(B) Gluten.

Tie a quarter of a cup of flour in a muslin bag, moisten well; then work the dough until it becomes smooth and elastic, and wash with cold water, until fresh water added no longer grows milky or shows the starch test with iodine. The sticky, elastic mass is called gluten. Save part of this for comparison with the other proteids, and bake the rest in a hot oven. Keep.

(C) Casein.

Add a little vinegar to some milk and heat it gently. Wash the curd thus formed in order to separate it from the whey. The curd is chiefly composed of casein. Make the test for nitrogen with a portion. Bake the rest in a hot oven.

(D) Myosin.

1. With a knife scrape a piece of lean meat until the tender muscle fibre is separated from the firm white connective tissue. The walls of the tubes or fibres consist of an albuminoid substance, elastin; the connective tissue which holds the fibres together is chiefly composed of the gelatinoid called collagen. The contents of these micro-

scopic fibres consist of water holding in solution the proteids myosin, muscle, albumin, and hæmoglobin — the myosin being the most important — salts and extractives.

2. Bake the scraped fibre in a hot oven.

(E) Examine the fleshy part of peas and beans. Has it any of the properties of gluten? How is it affected by a high temperature? Does it answer to the nitrogen test? Bake. Keep.

(F) Grind to a powder the gluten, the casein, the myosin, and the legumin that you have baked, and note the similarity in texture and appearance.

Note. — How to remove the proteids from liquids containing them:

1. Saturate with ammonium sulphate. This precipitates all proteids except peptones.

2. Acidulate faintly with acetic acid and boil. This removes globulins and albumins.

3. Acidify feebly with acetic acid, add several volumes of absolute alcohol; after twenty-four hours all proteids are precipitated.

4. Mix with one-half its volume of a saturated solution of sodium chloride and add tannic acid in slight excess. This precipitates all proteids.

EXPERIMENT 36.

Special Gelatinoids.

Appendix, References for Class Study, Section 6.

(A) Collagen.

1. Boil slowly for a long time bones, ligaments, and tendons. Set aside to cool. Test the gelatin that forms with cold water; with boiling water. Add picric acid solution to gelatin solution.

2. Repeat the tests, using commercial gelatin. Describe the manufacture of gelatin.

(B) Keratin.

Very insoluble, resists putrefaction for a long time; contains much sulphur.

1. Burn horn, hair, nail, skin, and note the odor.

2. Heat the above with strong sodium hydroxide solution. Add lead acetate solution. Lead sulphide appears as a brown or black precipitate. This proves that hair, skin, etc., contain compounds of sulphur.

3. Heat the substances used in 1 with "soda lime." (Soda lime is a mixture of the oxides of sodium and calcium.) Do you note the odor of ammonia? Hold a strip of moist pink litmus paper in the mouth of the test-tube while you heat it. Result? Conclusion? Pass some of the gas into Nessler's solution.[1] A dark precipitate shows the presence of ammonia.

This is a test for nitrogen compounds.

(C) Ossein.

Allow a small bone that has been boiled in water to remain in dilute hydrochloric acid (1 : 8) for several days. Wash the soft substance left, allow it to stand in a solution of sodium carbonate for a time, then wash well. Now boil it in water and gelatin will form.

Test with "soda lime" for nitrogen.

(D) Mucin.

To some clear saliva add acetic acid.

Mucin appears as a white precipitate.

[1] Nessler's solution is a water solution of potassium and mercuric iodide made strongly alkaline with potassium hydroxide.

EXPERIMENT 37.

Digestion of Nitrogenous Substances.

Appendix, References for Class Study, Section 6.

MATERIALS. Hard-boiled egg, pepsin, pancreatin, hydrochloric acid, baking soda, test-tube, labels.

(A) Action of Gastric Juice.

1. Thoroughly mince a piece of hard-boiled egg and place a portion of it in a test-tube; half fill the tube with water. Label — *Test No. 1, minced egg and water.*

2. Place in another test-tube the same quantity of minced egg and water as in tube No. 1; add a little dilute hydrochloric acid. Label — *Test No. 2, minced egg, water, hydrochloric acid.*

3. Into a third tube put some minced egg and water, and add a small amount of pepsin. Label — *Test No. 3, minced egg, water, pepsin.*

4. Place some of the minced egg in a fourth tube and add all three ingredients of gastric juice, namely: water, a little hydrochloric acid, and pepsin. Label — *Test No. 4, minced egg, water, hydrochloric acid, pepsin.*

5. Put a lump of the hard-boiled egg in a fifth test-tube; add water, hydrochloric acid, pepsin, as in test No. 4. Label — *Test No. 5, lump of egg, water, hydrochloric acid, pepsin.*

6. Put all five tubes in warm water (98° F.) and leave in a fireless cooker twenty-four hours. Examine them at the end of a few hours and at the end of twenty-four hours.

Results and conclusions.

Compare tests 1, 2, 3, 4, and 5.

In which tube has the egg been liquefied or digested?

Are all three ingredients of the gastric juice necessary for proteid digestion or not?

To what, therefore, may some cases of indigestion be due?

Compare tests 4 and 5.

In what tube is the digestion more complete?

What do you learn in regard to the effect of thorough mastication of food?

What provisions within the stomach, however, might accomplish the digestion of even poorly masticated food?

(B) Action of Pancreatic Juice.

1. Into a test-tube put some of the minced egg, half fill the tube with water, and add pancreatin; add to the mixture a little baking soda. Label — *Test No. 6, minced egg, water, pancreatin, alkaline salt.*

2. In a seventh tube mix the same quantity of minced egg, water, and pancreatin as was used in test No. 6, pour in a few drops of hydrochloric acid. Label — *Test No. 7, minced egg, water, pancreatin, acid.*

3. Put both tubes in warm water (98° F.) and leave in a fireless cooker twenty-four hours. Examine them at the end of a few hours and at the end of twenty-four hours.

Results and conclusions.

In which tube has digestion taken place?

Does pancreatin, therefore, perform its digestive action by the aid of an alkaline salt or an acid?

EXPERIMENT 38.

Fats and Oils.

First Principles of Chemistry, pages 387, 388. Appendix, References for Class Study, Section 7.

MATERIALS. Ground flaxseed, corn meal, egg, butter, mutton tallow, ether or benzine, olive-oil, sodium carbonate, caustic soda.

Caution! Never handle ether or benzine near a flame.

(A) Method of Extracting Oils.

1. To two or three teaspoonfuls of ground flaxseed add an equal volume of ether or benzine; stir the mixture and let it stand for ten or fifteen minutes. Filter and place the liquid aside in a good draught of air until the odor of ether or benzine has disappeared.

What kind of substance have you obtained? What is its odor? Why is benzine used to remove grease spots from clothing?

2. In the same way extract the fats from egg yolk and from corn meal.

(B) The Effect of Heat.

1. Hold a small piece of butter in your mouth. What change takes place?

2. Warm gently a piece of butter or mutton tallow in a spoon *over* the Bunsen flame. Increase the heat gradually. Explain the changes that occur. Why should fish be fried in deep fat? What care should be taken in the heating of fats or oils?

3. Burn a piece of fat until carbon remains.

(C) The Grease-spot Test.

Rub a little flaxseed on paper. Hold the paper to the light. Result?

Do starch, sugar, proteid, or water have a similar effect?

(D) Emulsion of Fats.

1. In a test-tube shake a few cubic centimeters of olive-oil with some caustic soda solution. Keep. What is an emulsion?

Examine a drop of this mixture with a compound microscope.

What is the appearance of the oil droplets?

2. Shake some olive-oil with a mixture of white of egg (albumin) and water. Keep. Examine a drop with a compound microscope.

3. Shake a few drops of olive-oil with water in a third test-tube, and let the tube stand for a time. What difference do you notice in the tubes?

(E) Saponification of Fats.

Boil the mixture made in (D) 1 for several minutes. If oil can still be seen, add more caustic soda and boil again. Examine a drop of the product with a compound microscope. What change has taken place? What kind of a substance has been formed? What is meant by saponification?

(F) Effect of Acids on Fats.

Pour a little melted butter into each of two old test-tubes. Add to tube No. 1 some dilute hydrochloric acid; to tube No. 2 some sodium carbonate solution.

Shake both tubes and allow them to stand a few minutes. Does the butter remain mixed better with an acid or an alkaline solution?

Why are fats not digested in the stomach? Why are acids not used to remove grease spots? Why is sal soda a good cleansing agent?

EXPERIMENT 39.

Mineral Matter in Foods.

Appendix, References for Class Study, Section 8.

MATERIALS. Piece of meat, oatmeal, egg, milk, vegetables, a tin pan, an oxygen generator, dilute hydrochloric acid, lime-water, hard glass tube, evaporating dish.

(A) The Mineral Matter in Bone.

1. Place a thin, clean piece of cooked bone in a bottle containing dilute hydrochloric acid; allow the bone to remain in the acid several days.

2. Pour into an evaporating dish some of the liquid in which the bone has soaked, and heat to dryness.

What does the substance resemble?

What kind of substances unite readily with acids?

Prove that the solid obtained is a compound of calcium.

(B) Mineral Matter in Foods.

1. Place portions of oatmeal, beans, meat, and other foods on a tin pan and heat in a free flame for an hour or longer.

What changes occur while the food is in the flame?

2. If a black solid remains, place it in a hard glass tube, connected at one end with an oxygen generator and at the other with a bottle of lime-water. (See Fig. 14.) Heat the tube strongly, then pass oxygen through it as long as any black solid remains.

What is left in the tube?
Does it burn?
Do mineral compounds burn?

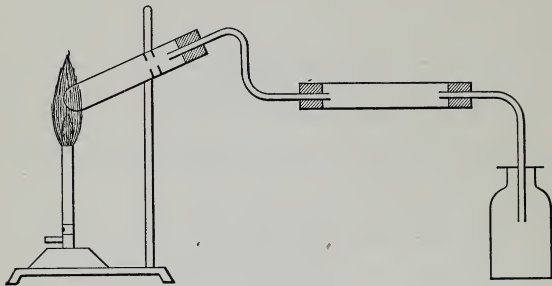


Fig. 14.

What was the black solid placed in the hard glass tube?
How can the mineral matter in foods be distinguished from carbohydrates, proteids, and fats?

EXPERIMENT 40.

Milk.

Appendix, References for Class Study, Section 9.

(A) Fats.

1. Put some milk into a clean dish and let it stand over night. What layers can be distinguished? Remove the top layer. Place a drop of it on unglazed paper. Let the paper dry. What kind of nutrient is shown to be present?

2. Place a portion of the skimmed milk in one tube of a centrifuge and balance with shot in the other tube. Whirl it for several minutes. Result? Why is the

"gravity" method of separating cream not used in creameries? What is the composition of cream? What per cent of fat do the laws of your city require dairy milk to contain?

(B) Nitrogenous Substances.

1. Boil a portion of the milk. Result? What kind of nutrient is affected in this way by heat? Remove the scum and test with nitric acid and ammonia. Result?

2. Let the remaining portion of the milk stand until it is thick and sour. What is the curd? With a spoon press out the greenish water (whey). What nutritive substances does it contain? Place the thick portion in a pan, add hot (*not* boiling) water and let it stand twenty minutes. Drain through a strainer. Add more hot water. Repeat until the curd loses its sour taste and has contracted. Why should the water be below the boiling point? Why is "cottage cheese" often tough? Buttons have been made of sour milk. What causes the souring of milk?

3. Make artificial buttermilk with cultivated bacteria. "Lactone" tablets make excellent buttermilk.

4. Warm a little sweet milk very slightly. Add some dissolved rennet, stir, chill it. This is known as junket. What change has taken place?

(C) To prevent Souring.

1. Boil a little milk (temperature 212° F.) for twenty minutes. Pour into a bottle and let it stand. Taste it. Observe the appearance. Does the cream rise as it does in fresh milk? This process is called sterilization. Does the sterilized milk sour as quickly as fresh milk?

2. Place a bottle of milk in water and heat the water

until the milk shows a temperature of about 155° F. Taste it. Keep it. Does it sour easily? This process is called pasteurization. Why? What advantages has pasteurized milk over sterilized milk? In what respects is it not so good?

(D) Specific Gravity of Milk.

1. Pour a pint of good rich milk into a 500 cubic centimeter graduate. Stand beside it a graduate containing a pint of skimmed milk, one containing a pint of partially skimmed milk and water, and one of whole milk and water.

2. Test the milk in each graduate with a lactometer. Which of the four portions has the greatest density? How does the addition of water to whole milk and to partially skimmed milk change the specific gravity?

Under what conditions would it be difficult to detect adulteration with water? When could the presence of water be easily detected?

EXPERIMENT 41.

Leavening Agents: Baking Soda — Baking Powders.

First Principles of Chemistry, pages 134, 248. Appendix, References for Class Study, Section 10.

1. In test-tubes mix a little baking soda, sodium bicarbonate, with the following substances: water, sour milk, New Orleans molasses, tartaric acid, cream of tartar, soluble phosphate of lime, alum, alum with soluble phosphate of lime.

2. Heat each tube gently, while introducing a blazing

splint into the mouth of the tube. To the tubes containing solids only add a little water and heat again.

What gas is evolved in each case? In which tubes is the gas evolved most rapidly? Explain the reactions that take place in each tube. What substances remain in the tube?

In the preparation of doughs, why is the present method of mixing soda with flour better than the old method of dissolving it in the sour milk used?

3. After the effervescence has stopped, add an excess of water to all but the first three tubes. In which tubes do the products dissolve?

There are three classes of baking-powders: tartrate, phosphate, and alum phosphate.

Of what does each consist? Which is the best class? Why?

Recall the solubility of the substances left after the effervescence ceased. Which is the harmful baking-powder? Why? What is the objection to the other class?

Why is starch used in baking-powder mixtures? Why is it better to buy a good baking-powder than to make one at home?

EXPERIMENT 42.

Practical Use of Leavening Agents.

Appendix, References for Class Study, Section 10.

(A) Baking-powder Biscuit.

MATERIALS. 2 cups flour, $\frac{1}{2}$ teaspoonful salt, 3 teaspoonfuls baking-powder, 1 tablespoonful lard, 1 tablespoonful butter, $\frac{3}{4}$ cup sweet milk (more or less).

1. Sift flour, salt, and baking-powder.
2. Add butter and lard, cutting it through the dry material, using a case-knife or two knives.
3. Add milk, cutting it in with a knife. Add just enough milk to form a dough which leaves the bowl.
4. Turn dough on a lightly floured board. Knead until the dough looks smooth. Roll about $\frac{1}{3}$ to $\frac{3}{4}$ inch thick and bake in a hot oven 8 to 10 minutes for small biscuit; 12 to 20 minutes for larger.

Oleo or cotto suet or other fats may be used instead of lard and butter.

Explain the action of the baking-powder.

(B) Soda Biscuit.

MATERIALS. 2 cups flour, $\frac{1}{2}$ teaspoonful salt, $\frac{1}{2}$ teaspoonful soda (1 teaspoonful baking-powder may be used with this). The soda must be fresh. Why? 1 tablespoonful butter or lard, $\frac{1}{2}$ cup sour milk or cream, or both.

1. Sift flour, salt, and soda.
2. Add butter or lard as in **(A)**.
3. Add sour milk as in **(A)** 3.
4. Complete as in **(A)**.

The dough will be richer if a tablespoonful of lard is used with 1 tablespoonful of butter, but it is quite satisfactory with only 1 tablespoonful of fat.

$\frac{1}{2}$ cup of cream or milk may be too much. It depends upon the sourness.

Explain the action of the soda.

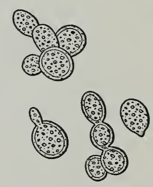
EXPERIMENT 43.

Yeast — Alcohol — Vinegar.

First Principles of Chemistry, pages 381–384, 386. Appendix, References for Class Study, Section 11.

(A) Yeast.

1. Mix about $\frac{1}{16}$ of a cake of compressed yeast with a tablespoonful of lukewarm water, and stir until a smooth thin mixture is formed. Pour the yeast and two teaspoonfuls of molasses into a large test-tube half full of warm water. Set the tube in a window, where the sun can warm it, or place it in warm water (temperature between 70° and 90° F.). Observe the odor and taste of the mixture. Is it clear or cloudy? Connect the test-tube with a bottle of clear lime-water.



Yeast highly magnified.
Fig. 15.

2. At the end of several hours examine the liquid and the lime-water. What evidence is there that the yeast is "working"? What has caused the change in the lime-water? Note the odor, taste, and appearance of the liquid.

Examine yeast cells with a microscope.

3. Shake mixture when it is working well, and pour a few cubic centimeters into a test-tube; place the tube in a refrigerator. Leave it several hours. Does the action continue while the tube is cold? Warm the liquid again to the temperature of the room. Result? Has the yeast plant been killed by the cold?

4. Boil a few cubic centimeters of the yeast mixture. What effect has the heat upon the activity of the yeast? What temperature is most favorable for the growth of yeast?

(B) **Alcohol.**

1. Pour into a flask some of the yeast mixture that has been working twelve hours or longer. Insert a two-hole rubber stopper. Through one hole pass a chemical thermometer, and through the other a tube attached to a condenser. (A simpler method of collecting the distillate may be used.)

Place the flask over a water-bath and keep the temperature 78° C. Collect the liquid that distils.

2. What does the odor of the liquid resemble?

3. Apply a lighted match to a little of it. What substances formed when fermentation took place? What change has taken place in the yeast? In the molasses?

4. If there is not enough liquid collected to burn, or if its nature cannot be determined by its odor, make the "iodoform" test, thus: To a little of the distilled liquid add a few drops of a strong solution of iodine in potassium iodide and then enough sodium hydroxide solution to nearly decolorize. Shake and stand aside. After a few minutes, note the odor and appearance.

If alcohol is present in the liquid tested, the odor of

iodoform may be easily recognized. If much alcohol is present, the iodoform will appear as a yellow solid.

(C) Vinegar.

Allow the remaining portion of the yeast-molasses mixture to stand uncovered in a warm place for several weeks. From time to time note the change in odor. Explain the chemical changes that take place. What substance is often made at home by fermenting fruit parings? What causes fruits that fall in an orchard to puff and become sour? Why do the bottles containing canned fruits sometimes burst? What is aldehyde? Why may fruits be made fit for *use* if they are reheated soon after fermentation begins? Of what use is yeast?

EXPERIMENT 44.

Practical Use of Yeast.

First Principles of Chemistry, page 248. Appendix, References for Class Study, Sections 10, 11, 12.

Bread — Short Process.

MATERIALS. 1 cup milk, 1 cup boiling water, 1 tablespoonful butter, 1 teaspoonful salt, 1 cake compressed yeast, $\frac{1}{4}$ cup lukewarm water, about 6 cups flour.

1. Put the milk into a mixing bowl, add cup of boiling water.
2. Dissolve yeast cake in lukewarm water.
3. Add salt and butter to liquid in bowl, and when lukewarm, add dissolved yeast cake.
4. Beat in flour until mixture will not stick.

5. Turn out on a floured moulding board and knead until the dough is smooth and full of bubbles.

6. Return dough to bowl, cover, and let stand until it doubles its bulk. Keep *warm* but not *hot*. Why?

7. Turn on to a floured board, knead lightly, mould into loaves. Put into greased pans and stand in a warm place until it again doubles its bulk.

8. Bake in a hot oven for thirty minutes.

Explain the physical and the chemical changes that take place during bread-making and bread-baking.

Why should the loaves of bread be separated when they are removed from the oven?

What causes the sour taste sometimes noticed in bread?

Bread — Long Process.

MATERIALS. $\frac{1}{4}$ cake of dry yeast, 1 teaspoonful butter, 1 teaspoonful salt, 1 teaspoonful sugar, 1 cup water, 3 cups flour.

(A) Sponge.

1. Soak the yeast in warm water until softened.
2. Place the sugar, salt, and butter in a bowl.
3. Add the warm water, yeast, and about one-half of the flour.
4. Beat smooth and let rise.

(B) Dough.

1. Add the remainder of the flour to the light sponge, stirring it in until it is well mixed (a little more or less than 3 cups of flour may be required).
2. Turn the dough on to a board and knead quickly until it is smooth and somewhat elastic to the touch.
3. Put the dough into a bowl and let rise in a warm temperature.

(C) Loaves.

1. When the dough has doubled its original bulk, knead it down well, make into loaves, and set to rise again in the pan in which it is to be baked.

2. When the dough has again risen to twice the original size of the loaf, bake from forty to fifty minutes, noting oven temperature every five minutes during the baking.

3. When baked, remove the loaves from the pan at once and cool them on a rack which allows a free circulation of air.

EXPERIMENT 45.

Tea — Coffee — Cocoa.

Appendix, References for Class Study, Section 13.

(A) To show Tannin and Theine in Tea.

1. Boil equal amounts of different varieties of tea in separate test-tubes for five minutes. Note the depth of color of the liquid in each tube.

2. Add to each tube a few drops of ferrous sulphate solution (copperas). Note the black tannate of iron that forms.

3. Boil some tea for ten minutes.

Pour the solution into an evaporating-dish and heat to dryness. Add a few drops of concentrated hydrochloric acid, and, at once, a fragment of potassium chlorate. Evaporate this mixture to dryness on a water-bath. If theine is present, a reddish yellow or pink color is produced.

Cool. Add a drop of ammonium hydroxide on the point of a stirring-rod. Theine produces a purple color.

4. Examine dry and moist tea-leaves with a microscope.

(B) To show Caffeine in Coffee.

Repeat (A) 3, using coffee.

(C) To detect Adulterants in Coffee.

1. Shake some ground coffee in cold water. Pure coffee usually floats on the surface, while ordinary adulterants sink ; chicory colors the water a brownish red.

2. Shake finely ground coffee into a tube containing a saturated solution of common salt. If the liquid is colored pale amber and nearly all of the solid floats, the coffee is pure. A dark yellow or brown color indicates adulteration with roasted cereals or chicory or both.

3. Spread some coarsely crushed coffee on a sheet of white paper and examine with a lens. The chicory grains, if present, will have a dark and gummy appearance. They are soft and are bitter to the taste. The surface of the crushed coffee grains is dull, while that of broken peas or beans is polished. The fragments of broken cereal grains may be easily detected.

NOTE. — Tannins are astringent principles widely diffused in the vegetable kingdom. They dissolve in water and have an acid reaction ; they are often called tannic acid. They form insoluble compounds with gelatin ; hence, are used in the preparation of leather. They give dark colored precipitates with ferric salts ; hence, are used in the preparation of ink.

(D) Cocoa.

1. Boil some finely ground cocoa with water. Filter while hot and save both filtrate and residue.

2. Test the filtrate for starch, sugar, and protein.

3. Dry the residue and extract the fat with gasoline.

EXPERIMENT 46.

Food Values — Menus.

References for Class Study, Section 14.

(A) Determine the weight of a slice of bread $\frac{1}{2}$ inch thick, of an egg, a serving of different vegetables, meats, fruits, and other foods. Record the weights.

(B) Make a table showing the foods used by yourself during one day, the food values in calories, and the cost.

Use the following form for **(B)** and **(C)**:

MENU FOR ONE DAY — 25 ¢.

NAME OF FOOD	OZ. WT.	DESCRIPTION	CALORIES PROTEID	CALORIES FAT	CALORIES CARBOHYDRATE	CALORIES TOTAL	COST
Breakfast:							
Oatmeal							
Luncheon:							
Rolls							
Dinner:							
Soup							

Total — Wt. 119 lb. requires

Difference

NOTE. — The weight of the person using the menu is to be used.

Compare the values obtained with those required, according to your weight.

Consult Norton's "Food and Dietetics" published by The American School of Home Economics.

(C) Select such foods for one day's menu for yourself as will give the required number of calories of energy, and also give the correct ratio between the nutrients, at a total cost of 25 ¢.

7. FOOD ADULTERATIONS.

EXPERIMENT 47.

Tests for Adulterants in Milk.

Appendix, References for Class Study, Section 15.

(A) To test Milk for Formaldehyde.

1. Place in a test-tube 6 or 10 cubic centimeters of milk and add an equal volume of concentrated sulphuric acid or hydrochloric acid, and a piece of iron alum about the size of a pin head. Mix the liquids with a gentle rotary motion.
2. Place the tube in a bottle or beaker filled with boiling water and allow to stand five minutes. A purplish color of the mixture shows the presence of formaldehyde.

When the acid is first added to the milk, before the addition of the alum, a pinkish tinge suggests the presence of a coal-tar color.

(B) To test Milk for Borax or Boric Acid.

1. Dissolve one gram of alum in 50 cubic centimeters of water and add 25 cubic centimeters of milk.

2. Shake vigorously and filter.

3. Pour a few cubic centimeters of the filtrate into a test-tube and add a few drops of concentrated hydrochloric acid.

4. Dip a piece of turmeric paper into this and hold it *over* (not in) a Bunsen flame until dry.

5. Place a drop of ammonia on the paper; a cherry-red color before adding the ammonia and a dark green or greenish black afterwards shows the presence of borax or boric acid. The latter test is the better, as an excess of hydrochloric acid may cause the filter paper to become a brownish red.

(Turmeric paper may be made by dipping filter paper into a solution of turmeric powder in alcohol.)

EXPERIMENT 48.

Tests for Adulterants in Butter, Meat Products, Mustard, Baking-powder.

Appendix, References for Class Study, Section 15.

(A) To distinguish between Oleomargarine, Rejuvenated Butter, and Fresh Butter.

TEST 1. Melt a small piece of the sample in a porcelain evaporating-dish, stirring with a splint of wood.

Oleomargarine and rejuvenated butter sputter and boil noisily, without producing foam, while real butter boils quietly and produces a large amount of foam.

TEST 2. Fill a test-tube half full of sweet milk with the cream thoroughly mixed, or skimmed milk may be used. Heat and add a teaspoonful of the sample to be tested. Stir with a wooden splint until the fat is melted.

Cool the test-tube in very cold water or in ice and stir the mixture until the fat hardens. If the sample is oleomargarine, it will harden in one mass and may be lifted out on the splint of wood.

If it is butter, either fresh or rejuvenated, it solidifies in granules scattered all through the milk in small particles.

From these two tests explain how you can distinguish between the three kinds of fat.

(B) To test Meat Products, as Sausage, for Sulphides.

1. Macerate the sample with water.

2. Pour into a flask and add pure zinc and hydrochloric acid. If sulphides are present, hydrogen sulphide will be liberated.

3. To test this, dip a piece of filter paper into a solution of lead acetate and suspend it in the flask. A black precipitate on the paper indicates the presence of hydrogen sulphide.

(C) To detect Turmeric in Mustard.

Add a few drops of ammonia and some water to the sample. A brown color will show the presence of turmeric, unless the amount present be quite small.

(D) To detect Alum in Baking-powder.

1. Put some logwood chips in an evaporating-dish, cover with water, and bring to a boil. Throw the water away. Do this three times, but save the fourth solution.

2. Fill a test-tube about half full of water and add a teaspoonful of baking-powder. Shake till effervescence ceases and add enough hydrochloric acid to make the solution acid.

3. To this solution add four or five drops of logwood extract. A bluish red color indicates the presence of alum. A yellow color shows its absence.

EXPERIMENT 49.

Tests for Adulterants in Candy, Jellies, Extracts, Ice-cream.

Appendix, References for Class Study, Section 15.

(A) Artificial Coloring-matter in Candy and Jellies.

1. Place some of the sample in water and boil to dissolve it.

2. Place in this liquid a few pieces of white woollen yarn. Boil for five or ten minutes, stirring occasionally.

3. Remove the cloth and wash in hot water. If the cloth is brightly colored, the presence of artificial dyes is shown.

4. To make the test more certain, place the cloth in a solution of dilute ammonia, boil for five minutes, and remove the cloth. The artificial coloring-matter dissolves in the ammonia.

5. If this is colored, add hydrochloric acid to it till the mixture is acid.

6. Place in it a fresh piece of white yarn and boil.

7. Remove and wash in water. If the cloth is colored, the presence of artificial dyes is proved.

This may be a coal-tar derivative or a vegetable color. If the former, the cloth is usually turned blue or purple by the ammonia.

(B) To test Extracts.

1. Vanilla.

Evaporate a quantity of the extract to about one-third its original volume. Add enough water to restore the first volume. The resins will be thrown down as a brown flocculent precipitate. If a precipitate is formed, add a few drops of hydrochloric acid, stir, filter, and wash with

water. Dissolve the precipitate on the paper in a little alcohol. Divide this into two portions. To one add a piece of ferric alum, and to the other a few drops of hydrochloric acid. If neither produces more than a slight change of color, the pure extract of the vanilla bean was used. If there is a distinct change of color, extracts from other sources are present.

2. Lemon.

To a test-tube nearly filled with water add a teaspoonful of the extract.

If real lemon is present, it will be thrown out of solution and will give a turbid appearance to the solution. It will form a layer on the top of the water. If the solution remains clear, after diluting with water, very little or no oil of lemon is present.

(C) To test Ice-cream.

1. For glucose:

Add Barfoed's solution to a portion of the cream to be tested. Boil. If a red precipitate appears, glucose is present.

2. For starch:

Test with iodine.

3. For gelatin:

To 10 cubic centimeters of the ice-cream add 20 cubic centimeters of cold water and 10 cubic centimeters of acid mercuric nitrate. Shake vigorously. Allow to stand five minutes. Filter. If much gelatin be present, it will be impossible to get a clear filtrate. Mix a portion of the filtrate with an equal bulk of a saturated water solution of picric acid. If any gelatin be present, a yellow precipitate will be produced immediately.

8. SOAPS.

EXPERIMENT 50.

Soaps — Hard Water.

First Principles of Chemistry, pages 131, 263, 387–389. Appendix, References for Class Study, Section 16.

MATERIALS. Sodium hydroxide, lard, salt, soap, sulphuric acid, calcium sulphate, magnesium sulphate, acid calcium carbonate.

(A) Preparation.

1. Dissolve two grams of sodium hydroxide in 15 cubic centimeters of water, add six grams of lard, and boil until the mixture begins to solidify.
2. Then add four grams of salt in small portions.
3. Stir constantly while adding the salt.
4. Boil a few minutes. Cool. Remove the soap.

(B) Properties.

1. Leave small pieces of soap exposed to the air for several days. What does the soap lose?
2. Dissolve a little soap in distilled water; shake, boil, and stand aside. Effect?
3. Dissolve some soap in city water. What difference do you notice?
4. Divide the distilled water solution into three portions. To the first, add a distilled water solution of calcium sulphate, and to the second, one of magnesium sulphate, and to the third, calcium bicarbonate solution. Boil each mixture a few minutes. Describe the result.

The calcium bicarbonate (acid calcium carbonate) may be prepared by passing carbon dioxide into lime-water until the precipitate that forms is dissolved.

What chemical changes have taken place? Name the soaps that you have prepared in this experiment.

Why does city water not make a good soapsuds? What is soft water? What is permanent hardness? Temporary hardness?

5. To some city water in separate test-tubes add a few drops of kerosene, a few small crystals of borax, and a little sal soda. What change in appearance and in the feel of the water do you notice? Now add soap. Shake. Does a suds form? What resemblance is there between the action of soap and of borax upon hard water?

How do kerosene, borax, and sal soda soften water?

9. CLOTHING.

EXPERIMENT 51.

Textiles — Fibres.

Cotton — Wool — Linen — Silk.

First Principles of Chemistry, pages 390, 391. Appendix, References for Class Study, Section 17.

1. Examine fibres of cotton, wool, linen, and silk with a compound microscope.
2. Test each with warm dilute acids — nitric, hydrochloric, sulphuric, oxalic. Let the fibres dry.
3. Repeat 2, using concentrated acids.
4. Test with sodium hydroxide solution.
5. Rub each with soft soap; with a sodium soap.
6. Burn each. Note the odor.
7. Pour boiling water on each. Rub.

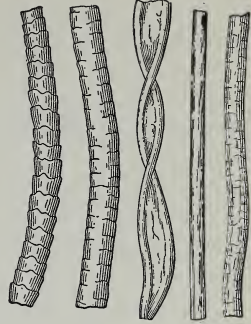
8. Repeat 7, using tepid water.

9. Dye each with aniline dye.

10. Add cold water drop by drop. Which takes the most water without appearing damp?

11. Iron pieces of cloth, made of the fibres, with a hot iron.

12. Test the effect of strong salt water on pieces of cloth made of the fibres.

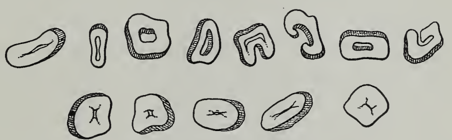


a, Wool; b, Mohair; c, Cotton; d, Silk; e, Linen.

Fig. 16.

How could you be sure that a certain piece of dress goods was all wool? How could you distinguish artificial silk from real silk?

What care should be taken in washing woollen garments? Why?



Sections of Cotton Fibres.

Fig. 17.

Why should a silk dress not be splashed with sea water? Why are garments made of linen and cotton so durable? Why are woollen garments often worn in warm weather?

EXPERIMENT 52.

Stains.

Appendix, References for Class Study, Section 18.

(A) Removal of Acid Stains.

1. Place a few drops of moderately concentrated hydrochloric acid, nitric acid, and sulphuric acid upon pieces of cotton and woollen cloth. Note the effect.

2. Quickly rub each spot with a cloth wet with dilute ammonia and then rinse with water. Which stain cannot be removed by ammonia? Explain the chemical action of the ammonia.

(B) Grease Spots — Paint. (Caution!)

By solution:

1. Make a spot upon cloth with olive oil; with butter, lard, and oil paint.

2. Place a clean white cloth underneath the spot, turning the right side of the spotted fabric to the cloth.

3. Rub the spot with naphtha, gasoline, or alcohol, rubbing from the outside toward the centre until dry.

4. Use turpentine for another paint spot. What other solvents may be used? What solvent is to be preferred for spots on silk? The solvents should be used in the open air — never near a flame.

By absorption:

1. Place a piece of blotting paper over a grease spot and press it with a warm iron.

2. Moisten some French chalk or talcum powder with naphtha and spread the mixture over a grease spot. When it is dry, brush off the chalk. Garments may be sprinkled

well with the chalk only and folded; if left several hours and then shaken well, the fabric will be fresh and clean.

(C) Grass Stains.

Try to remove grass stains with alcohol, ammonia, molasses.

(D) Coffee, Tea, Fruit Stains.

1. Stretch the stained part over a bowl and pour boiling water through it.
2. Sprinkle another stained piece with borax and soak it in cold water, then apply boiling water.
3. If the stains are old, use bleaching powder.

(E) Mildew.

1. Moisten a piece of cloth and place it in a warm, dark place. Leave it until spots have appeared.
2. Try to remove the spots with strong soapsuds; with soft soap and pulverized chalk, with chalk and salt, and with bleaching powder.
3. After the removing agent has been applied, place the cloth in strong sunlight. What is mildew? Why is it difficult to remove an old stain?

(F) Vaseline.

1. Soak a cloth, stained with vaseline, in kerosene.
2. Then wash with soapsuds. Why may soap or an alkali not be used to remove vaseline?

(G) Ink.

1. Stain some white fabric with common ink. Stain colored material.
2. Cover the spot on the white fabric with salt, wet it with lemon juice, and spread it in the sun. Let it stand

several days. As often as the salt becomes stained, remove it and add fresh salt and lemon juice.

3. Stretch the colored material over a bowl and pour sweet skimmed milk upon the spot. If it does not disappear, place it in some clean sweet milk and let it remain until the milk sours. If a grease spot is left, remove it with naphtha.

4. Place a piece of blotting paper under an ink spot and a piece of ice over it. Change the blotting paper as soon as it becomes stained.

5. Try to dissolve a stain, made by indelible ink, with sodium hyposulphite.

Try to dissolve another with bleaching-powder solution.

If lampblack has been used in the ink, it cannot be dissolved.

Some ink stains may be removed by cold water.

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Perfumes, Dyeing.

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LIST OF SUPPLIES.

The following list includes the apparatus, chemicals, and other supplies for use with the experiments in this book.

General Apparatus.

Asbestos squares, 6″ × 6″.
Bags, rubber, gray, oval shape.
Balances, automatic, Vienna confectionery.
Balances, pulp, 17½″ × 8″ × 15″.
Basket, wire, frying, 8″ × 10″.
Bath, water, diameter 6″.
Beakers, glass, Jena, lip, both forms, 200 c.c.
Bell jar, 6″ × 11″ inside, 1 gallon.
Boiler, double, granite, 1 pint.
Bottles, 8 oz., 16 oz., 32 oz., salt mouth, glass stopper.
Bottles, 8 oz., 16 oz., 32 oz., reagent, blown labels.
Bottles, wide-mouth, 250 c.c.
Bowls, mixing.
Brushes, test-tube.
Burners, Bunsen, single; wing-top for same.
Clamps, Mohr, spring, compress, 2½″.
Clamps, test-tube, Stoddard's, spring brass wire.
Clay pipes.
Condenser, Liebig, glass, 20″.
Corks, assorted, #0–#11.
Crucibles, Hessian, 4″ × 2½″.
Cups, measuring, granite, 1 quart by fourths.
Cups, measuring, granite, 1 pint by fourths.

Dishes, baking, granite, rectangular, $6'' \times 9''$, with handles.
Files, triangular.
Filter paper, Munktells'.
Fireless cooker.

NOTE. — The fireless cooker may be made by the students.

Flasks, Florence, 8 oz., 16 oz.
Flasks, fractional distilling, 6 oz.
Forceps, steel, plain, strong, 5″.
Funnels, glass.
Funnels, tin, 3″ diameter.
Gas measuring tubes, 50 c.c., graduated in $\frac{1}{5}$ c.c.
Gas plate, 2 burners with oven.
Graduates, glass, cylindrical, lipped, 500 c.c.
Hoffman apparatus for electrolysis of water.
Kettle, frying, Scotch, round bottom, 2 quarts.
Knives, French, bowing, 5″.
Labels, gummed, Dennison's.
Lactometer.
Litmus paper, blue and pink.
Microscope, compound.
Microscopes, magnifying lenses, 25 m.m.
Mortars, iron, with iron pestle.
Mortars, porcelain, with pestle.
Pan, French fry, 10″.
Pan, stew, with cover.
Plates, glass, $3'' \times 3''$, cover glasses.
Plates, pie, granite.
Racks, test-tube.
Ring-stands with clamp and rings.
Scissors, best steel.
Screens, wire cloth, steel, 1 m.m. mesh, $4'' \times 4''$.
Sharpener, carborundum, rect., $6'' \times 2'' \times \frac{3}{4}''$.
Spoons, mixing, granite.
Spoons, deflagrating, bowl $\frac{1}{2}''$.

Stoppers, rubber, 1 hole, 2 holes.
Strainer, sink, woven wire basket.
Thermometers, 0″–200 C.
Troughs, pneumatic.
Tube, cylindrical, 18″, one end closed.
Tubes, calcium chloride, 8″, straight, 1 bulb.
Tubes, calcium chloride, U-shape.
Tubes, side-neck, 8″ × 1″.
Tubes, safety, funnel, 1 bulb.
Tubes, test, 5″ × $\frac{3}{4}$″, Jena glass.
Tubes, test, 8″ × 1″, Jena glass, ignition.
Tubing, glass, soft and hard.
Tubing, rubber.
Watch glasses.
Weights, brass.
Yardstick.

Chemicals and Other Materials.

Acetic acid, 30%, chem. pure.
Agar agar.
Albumen, blood.
Albumen, egg.
Alcohol, absolute.
Alcohol, ethyl, 95%.
Alcohol, wood.
Alizarine, paste, 25%.
Alum, chrome, cryst., c.p.
Alum, ferric, cryst., c.p.
Alum, potassium, c.p.
Aluminum carbide, lumps.
Ammonium carbonate, c.p.
Ammonium chloride, c.p.
Ammonium hydroxide, c.p., sp. gr. 0.9.
Ammonium oxalate, cryst., c.p.
Ammonium sulphate, c.p.
Ammonium sulphide, c.p.
Aniline.
Baking powder, several brands.
Barium chloride, cryst., c.p.
Beeswax.
Benzine.
Bleaching-powder.
Borax, cryst., c.p.
Boric acid, cryst., c.p.
Calcium acid phosphate, c.p.
Calcium carbide, lumps.
Calcium carbonate, marble.
Calcium chloride, cryst., c.p. (small bottle).

Calcium chloride, granular, for drying tubes.
Calcium hydroxide.
Calcium oxide, good quality, quicklime.
Calcium sulphate, gypsum, cryst. and powder.
Candles.
Carbon disulphide.
Chalk, French.
Charcoal, animal, bone-black.
Charcoal, wood, powder.
Charcoal, wood, sticks.
Cheese-cloth.
Citric acid.
Cloth, cotton, wool, linen, silk.
Copper oxide, powder, black, c.p.
Copper sulphate, anhydrous.
Copper sulphate, cryst., c.p.
Copper wire, spool.
Cotton, absorbent.
Cream of tartar.
Ether.
Extracts, lemon and vanilla.
Fehling's solution No. 1 and No. 2, or tablets.
Ferric chloride, cryst., c.p.
Ferric nitrate, c.p.
Ferrous sulphate, cryst., c.p.
Flaxseed.
Formaldehyde.
Gasoline.
Gelatine.
Glucose.
Glycerine.
Graphite.
Gum arabic.
Hydrochloric acid, c.p.
Indigo.
Iodine, resublimed.
Iron, picture wire.
Iron filings.
Kerosene.
Lampblack.
Lead acetate, cryst., c.p.
Lead nitrate, c.p.
Litmus cubes.
Logwood chips.
Magnesium ribbon.
Magnesium sulphate, cryst., c.p.
Manganese dioxide, granular, free from carbon.
Matches, all kinds.
Mercuric, acid nitrate.
Mercuric oxide, red.
Molasses, good quality.
Mustard.
Mutton tallow.
Naphtha.
Nessler's solution.
Nickel nitrate, cryst., c.p.
Nitric acid, c.p.
Oils, olive and linseed.
Oxalic acid, cryst., c.p.
Paint, oil.
Pancreatin, active.
Paraffin.
Pepsin.

Phosphorus, yellow.
Picric acid, cryst., c.p.
Platinum foil, small squares.
Potassium chlorate, cryst.
Potassium hydroxide, sticks, c.p.
Potassium iodide, c.p.
Potassium nitrite, c.p.
Potassium permanganate, cryst. c.p.
Rochelle salt.
Rosin.
Sand.
Schweitzer's reagent.
Shellac.
Silver nitrate.
Soda lime.
Sodium acetate, c.p.
Sodium bicarbonate.
Sodium carbonate, cryst., c.p.
Sodium chloride.
Sodium hydroxide.
Sodium hyposulphite.
Sodium nitrate, c.p.
Sodium nitrite, sticks, c.p.
Sodium sulphate, cryst., c.p.
Starches, corn, potato, laundry.
Sugars, cane, white and dark brown, grape, milk.
Sulphur flowers.
Sulphuric acid, c.p.
Talcum powder.
Tannic acid, c.p.
Turmeric paper.
Turpentine.
Various food materials.
Vaseline.
Vinegar.
Yeast.
Zinc, granulated, mossy.
Zinc sulphate, c.p.

NOTE.— Students are usually willing to furnish the food materials and textiles.

Im Vaterland: A Reader for Pupils in their First or Second Year of German

By PAUL V. BACON. 12mo, cloth, 430 pages. Price $1.25.

"TO give the American student a better understanding and appreciation of Germany and the Germans; to furnish him with an adequate vocabulary of colloquial idioms; to point out and explain differences between German and American customs; in short, to broaden and deepen the American's knowledge and love of the German language, music, poetry, and people; these are the aims of *Im Vaterland*."

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THIS book was prepared by the committee of teachers that was called upon to frame the syllabus in Chemistry for New York State. Its three fundamental features are:—

1. The experimental evidence precedes the chemical theory.
2. The historical order is followed as far as possible in developing the theory.
3. The practical aspects of the science are emphasized.

In selecting their material the authors have been governed wholly by what they consider its intrinsic value to the elementary student, without reference to its traditional place in a text-book.

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By Dr. HAROLD W. FAIRBANKS, of Berkeley, California. 8vo, cloth, 570 pages, 403 Illustrations. Price, $1.60.

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